Winter 1971

South Dakota Farm & Home Research

Agricultural Experiment Station, South Dakota State University

South Dakota Farm & Home RESEARCH

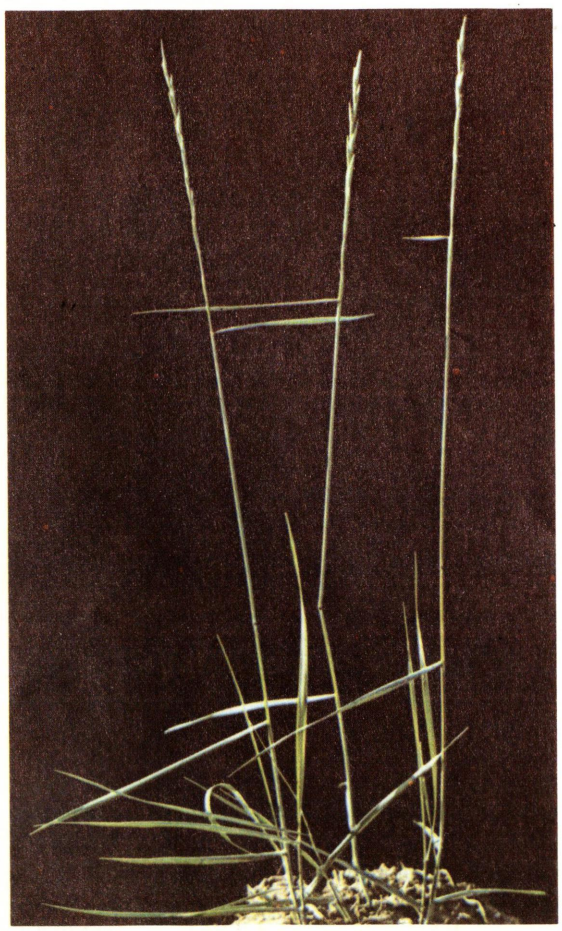
South Dakota's official State Flower and State Grass are two of the more than 200 full color and line drawing illustrations in the new publication, "Plants of South Dakota Grasslands—A Photographic Study." Plants pictured and described in the publication are found in the Great Plains from Canada to Texas as well as in regions farther to the west and east. See page 3 for descriptions of the two plants shown here.

Pasqueflower

Anemone patens

Western wheatgrass

Agropyron smithii



In this issue . . .

Vol. XXII • Winter 1971 • No. 1 • Agricultural Experiment Station • South Dakota State University, Brookings

From the Dean and Director:

Strengthening Our Knowledge of Environment

Duane Acker

THE SUBJECTS of environment and pollution will be high on the list of educational efforts at South Dakota State University during 1971.

At least three major events are in the planning stage for the next few months that will provide a wide range of activity for educators, technical personnel, and the public. These events will be University-wide in order to tap to the fullest the many resources of manpower and facilities available at SDSU.

Mid-March has been tentatively selected as the time for a seminar on environment, patterned somewhat on the highly successful symposium held on the campus at the same time in 1970. The emphasis more than likely will be on reports of SDSU research progress on projects dealing with pollution.

An environmental education workshop is anticipated in July, mainly for junior and senior high school teachers. Preliminary plans suggest that the workshop will provide these teachers with some of the latest instructive techniques and methods using environment as the central subject. One of the objectives is to give exposure to a teaching "package" that will provide knowledge through stimulation of interest of junior and senior high school students. The workshop would be for all teachers at these levels regardless of the subject matter they teach.

A third event is an Environmental Summer Session on L.I.F.E. (Living In Future Environments), tentatively being planned for August. The purpose of the session is to enable us to understand our physical and cultural environments and what we must do to properly develop future environments in which we can live.

The August event would also include special evening programs dealing with South Dakota's environment under possible topics of use of mineral resources, water pollution, agricultural pollution, and remote sensing as a pollution detection tool.

The regular sessions would be conducted by a faculty made up of personnel from civil engineering, health science, plant science, mechanical engineering, history and geography, botany-biology, horticulture-forestry, animal science, agricultural engineering, wildlife and fisheries sciences, rural sociology, and health, physical education and recreation.

Also of major importance is what we will be doing in education and research on environment throughout the year. This consists of the dozens of undergraduate and graduate courses which students throughout SDSU will be taking that deal in varying intensities with environment and its many aspects.□

Published quarterly by the Agricultural Experiment Station, South Dakota State University, Brookings, South Dakota. This publication will be sent free to any resident of South Dakota in response to a written request.

To simplify terminology, trade names of products or equipment are sometimes used. No endorsement of specific products or equipment named is intended, nor is criticism implied of those not mentioned.

A Report of Progress

Vol. XXII • Winter 1971 • No. 1

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South Dakota
Farm & Home
RESEARCH

SERVING THE PEOPLE OF SOUTH DAKOTA THROUGH TEACHING, RESEARCH, EXTENSION

The illustrations on the cover of this issue of South Dakota Farm & Home Research and the descriptions on this page are from Bulletin 566, "Plants of South Dakota Grasslands—A Photographic Study," published by the Agricultural Experiment Station, South Dakota State University, Brookings, S. D., 57006.

South Dakota's State Grass:

WESTERN WHEATGRASS

Western wheatgrass is a native, cool-season, sod forming grass with very strong rhizomes. Leaves are stiff, flat when green, rolled when dry, mostly glabrous, strongly ribbed on the upper surface, and feel rough to the touch. Stems and leaves are generally blue-green giving rise to a less-preferred name, bluestem wheatgrass. There is considerable variation in the spike (seed head), with spikelets having 6-10 stiff florets.

Western wheatgrass is found in most of the United States except in the area from Maine to Florida to Mississippi. It is a major range grass in the Northern and Central Great Plains, frequently occurring in nearly pure stands. Western wheatgrass is moderately alkali tolerant and grows on soils ranging from sands to clays, but is most important on fine-textured soils. On very fine clays it often shares dominance with green needlegrass, but frequently occurs in nearly pure stands. It is the most important grass in the wetter regions of the Mixed Prairie, in areas transitional to True Prairie, and in drainageways of the drier portions of the Mixed Prairie. Western wheatgrass was designated the State Grass of South Dakota in 1970 by action of the state legislature.

This grass is palatable and nutritious when green in the spring, and moderately so during other times of the year. It is commonly used as a hay crop during high precipitation years or when supplemental water is available. Vigorous rhizomes make western wheatgrass one of the more tolerant of the desirable and abundant grasses to grazing pressure and drought. Grazing abuse, however, especially in May and June, will decrease its abundance. When growing conditions improve, following drought and/or overgrazing, it may rapidly recolonize areas previously occupied. Western wheatgrass is considered a decreaser in areas having less than about 15 inches of annual precipitation, but it can temporarily invade areas previously occupied by tall grasses, when they are forced out by severe conditions. Seedings of this grass are common, but establishment may be slow due to poor seedling vigor.

Montana wheatgrass, *A. albicans*, is a closely related species found in northwestern South Dakota on very fine textured upland soils. Its abundance in localized areas makes it an important range grass. In appearance it is quite variable, but resembles western wheatgrass. Short rhizomes make the plants tufted in appearance. The leaves are softer than those of western wheatgrass. Short, half-inch awns are common and may curve outward from the seed head. When present, the awns make Montana wheatgrass easy to distinguish from western wheatgrass.

South Dakota's State Flower:

PASQUEFLOWER

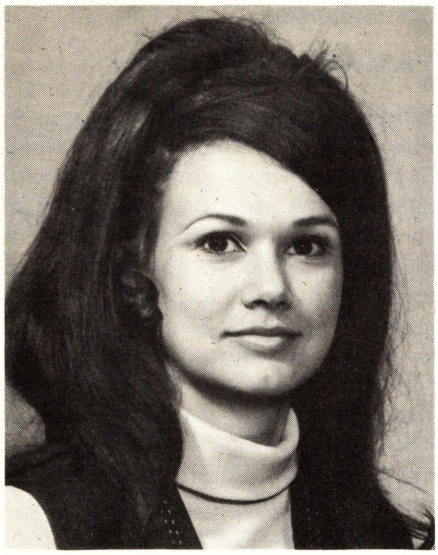
Pasqueflower, wild crocus, windflower, or mayflower, is a native, perennial forb 4-6 inches tall. The tulip-like flowers are 1-1½ inches across and vary in color from white to purple. Leaves are silky, mostly basal, and dissected into narrow linear divisions. As the seeds ripen, attached appendages persist becoming long and feathery. Stems elongate after flowers blossom.

Pasqueflower ranges from Alaska south to Utah and Texas, northeast to Illinois and Wisconsin and westward to Alberta. In South Dakota, pasqueflower is found on grassy hillsides across the State, as well as in wooded areas.

This plains beauty, the State Flower of South Dakota ". . . elected queen of flower land by the legislature of South Dakota, need never fear to stand in any flower company, however distinguished, however beautiful, however charming . . ." Soon after the snow melts, pasqueflower charms the prairies with large downy buds, then hardy, short-lived blossoms.

Pasqueflower palatability is fair but because it produces very little forage and dries by midsummer, it is unimportant for grazing. Pasqueflower has been suspected of being poisonous to livestock and apparently has caused mechanical blockage in the digestive tracts of sheep. The Indians used crushed leaves of pasqueflower as a counter-irritant for treatment of rheumatism and other painful ailments.

Spike of western wheatgrass



Mrs. Linda Petrich Clifford who conducted research relating to buying habits of young women while obtaining her master's degree in textiles and clothing at SDSU. Mrs. Clifford is now an instructor in the Division of Home Economics, University of Wyoming, Laramie. (UW Photo-Pownall.)

I—Buying Practices Studies.

When Your Young Daughter Buys Clothes

IF YOU ARE a South Dakota parent harried by the clothing needs of a teenage daughter in high school, happily you can look forward to fewer clothing buying sprees when she goes to college.

But Mom and Pop had better get prepared for their in-college daughter to spend more for the clothing items that she does buy.

And the man on the other end of the shopping line — the retailer — might, with a closer look, find that the younger girls are more interested in quantity for their money while their in-college sisters go more for quality of garments. Furthermore, the retailer may by now have learned that South Dakota gals seldom purchase clothing that has been advertised in fashion magazines or modeled at fashion shows.

These are just a few of the insights into clothing purchasing habits of South Dakota young women gleaned from the first of a series of investigations by home economists from the Agricultural Experiment Station. The series seeks more information on buying practices of segments of the state's population.

The study centered on 867 single junior girls in South Dakota high schools and colleges who were interviewed through questionnaires by Mrs. Linda Petrich Clifford while obtaining her master's degree in textiles and clothing at South Dakota State University. Information obtained is being used in textiles and clothing classes, including those at SDSU and at the University of Wyoming where Mrs. Clifford is now an instructor.

Some Surprises

"There were some mild surprises along the way," says Mrs. Adaline Snellman Hsia, head of the SDSU department of textiles and clothing who was Mrs. Clifford's adviser. "For instance, the total college group shopped more often than expected in specialty stores, whereas the high school group shopped more often in department stores, discount stores, and from mail-order catalogs."

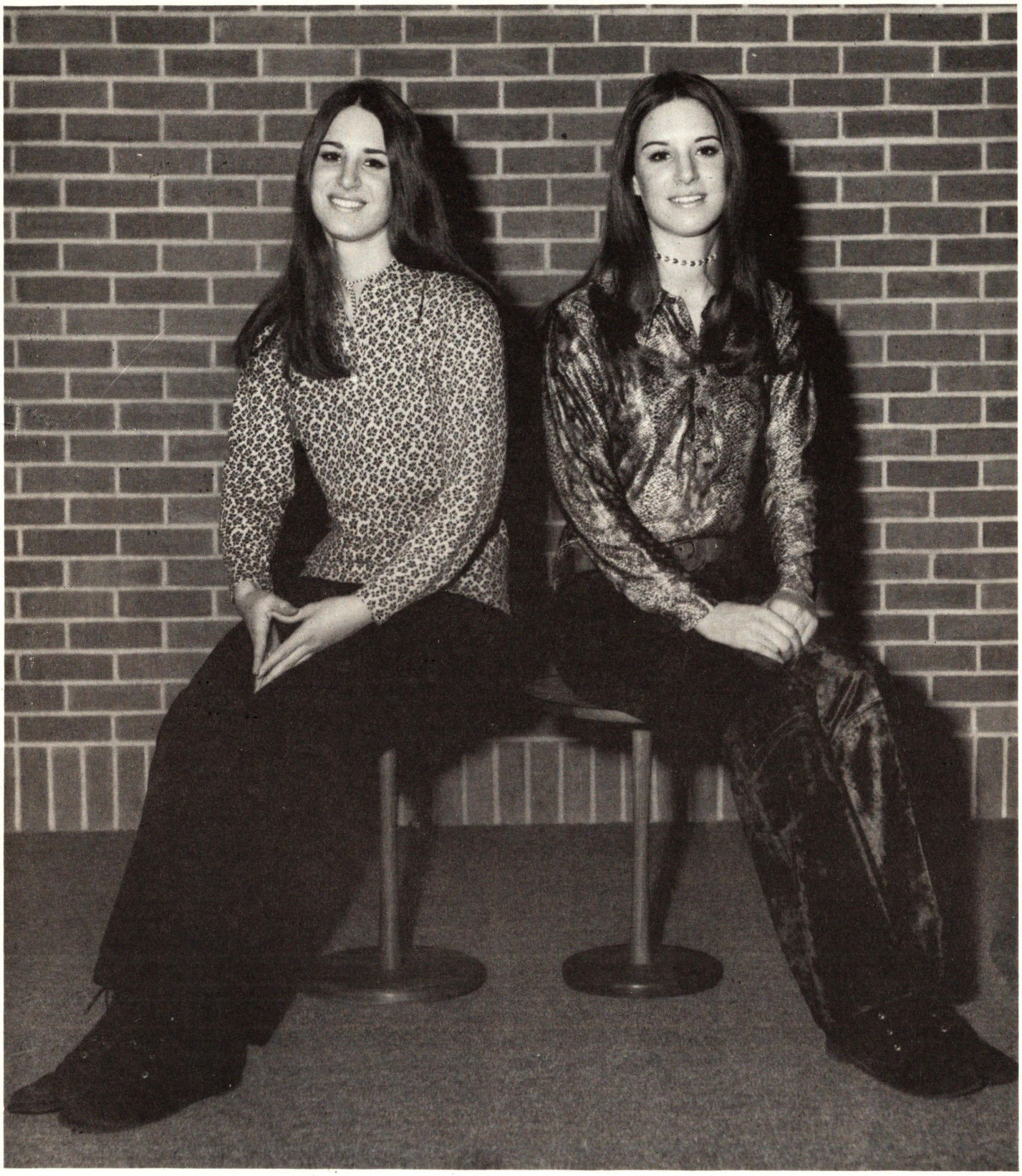
Results of the research, says Mrs. Clifford, should be useful to clothing teachers, parents, the young adult population itself, and to retailers and advertisers interested in high school and college women as consumers.

Involved were girls from 32 high schools with enrollments ranging from less than 100 students to more than 2,000 and from five coeducational colleges and universities with enrollments both below and above 1,500 students. Average age of the high school juniors was 16 years, of college juniors 20 years.

Why only juniors? "Because freshmen are still adjusting to their new school roles and senior students are likely to be influenced by future career and personal roles," says Mrs. Clifford.

Nearly three-fourths of the girls "guessed" their parents' annual net income at between $3,000 and $9,999 although about 8% of each

(Please turn to page 6)



While the SDSU study of teenage girls' buying habits didn't specifically go into what happens with twins in the family, the parents of Marcia and Margo Greichus might provide some hints. The Greichus twins, now seniors at Brookings High School, don't always dress exactly alike — they often use a mix-and-match system for a variation and possibly provide some two-for-one purchasing savings. Their parents are both associate professors at SDSU, Dr. Algirdas Greichus in the Entomology-Zoology Department, and Dr. Yvonne A. Greichus in the Station Biochemistry Department. Margo is the twin in the flowered blouse, Marcia is slightly taller of the two.

Daughter's Buying Habits
(from page 4)

group estimated parents' income at less than $3,000. The largest percentage of fathers were farmers or ranchers.

Source of Money

More high school girls received weekly allowances or money as needed than did college girls who received an allowance for each semester or no allowance. Girls from smaller high schools tended to receive less money from their parents for general spending than did those from larger high schools. Major sources of money for the high schoolers were: specific clothing money from parents, part-time earnings, summer earnings, and general allowance. The college girls listed their financial sources as summer earnings, part-time earnings, specific clothing money, and general allowance.

Briefly, here are some of the findings:

High School Groups

High school girls spent more of both their general allowances and part-time earnings on clothing than did college students. Many high school girls spent 50% or more of their allowances on clothing.

Girls from larger high schools tended to shop for clothes more frequently—and in their home towns—than those from the smaller schools, many of whom traveled to other towns or cities.

More girls from smaller schools sewed a major part of their wardrobes.

Those from smaller schools tend to look more at mail-order catalogs and pattern books to learn what was "in" while those from larger schools were more likely to base their purchases on trends from fashion shows.

Mother's opinion was most often considered by the girl from a high school with less than 700 enrollment while the girl from a school with more than 700 students was more likely to consider their girl friends' opinions.

Girls from larger high schools used some form of credit to pay for clothing purchases; girls from smaller high schools usually paid cash.

College Groups

Although the largest number of girls in both sizes of colleges seldom shopped in discount stores, when they did they were usually from small colleges.

Sweaters were purchased from mail-order houses by more subjects from smaller colleges and they also owned more hand-knit sweaters.

Girls from larger colleges spent higher amounts for summer dresses and school shoes.

Girls from smaller colleges indicated difficulty in finding garments that were becoming to their personal coloring.

Differences Among Groups

Parents of the high school teenager seemed to more often object to the clothing purchases – the research did not indicate if the objection was due to style and type or to the greater frequency of buying.

The college group had more who planned wardrobes and generally knew what they wanted to buy when they went shopping. High schoolers tended to have a vague idea or no idea of what they wanted to buy.

Fashion trends for high school girls were often obtained in fashion magazines; college girls also looked at newspaper advertisements.

College students were less likely to ask for the sales clerk's advice when shopping for clothes.

Both groups rated style and fit as most important attributes in selection of a winter dress. Color was second in importance to college girls but third for high school girls, who ranked prices higher in their selection process than college girls.

Similarities

The general pattern was to shop in a fourth to a half of the available stores.

Clothing similar to friend's apparel was purchased sometimes.

The majority of both groups spend 25% or less of total clothing budget on sewing materials.

Three over-all conclusions reached by Mrs. Clifford: Clothing buying practices of high school junior girls are related to the size of school attended. The size of college doesn't have much to do with clothing buying practices of college junior women. Most clothing buying practices of college women are different than those of high school girls.□

Pasture Interseeding

Cattle grazing an interseeded pasture in Union County, southeastern South Dakota in June. Note the interseeding furrows on the contour (background).

The same Union County pasture in the fall. Note that the chunks of sod have disappeared.

AN UPSURGE of interest in reviving old, worn-out pastures in South Dakota could give the countryside a "new look" with more beef on better grass, a slight shifting in cropping patterns, plus a measure of pollution abatement by reducing silt from soil erosion.

"Farmers who try interseeding grasslands with pasture type alfalfas—after they get over an initial shock—become some of the most ardent boosters," claims Charles Norby, Union County Extension agent.

"That initial shock often comes from the somewhat torn-up appearance of a pasture right after interseeding," Norby adds. "But gradually the interseeding ridges disappear and are almost entirely gone within a year or two. When those first alfalfa plants appear in the interseeded row, the owner becomes more reassured and by the time he has alfalfa growing a foot high he either wishes he had interseeded more of his land, or had done it years ago."

Interseeding Catching On

Pasture interseeding is gradually

(Continued on page 8)

Jack Donnelly likes the way interseeded furrows hold water on his pasture 10 miles northwest of Elk Point in Union County.

Alfalfa growing in an interseeded furrow on the Donnelly pasture in Union County. This was seeded about 2 weeks previously. The chunks of sod removed from the furrows will weather away.

"catching on" in South Dakota. Raymond A. Moore, head of the Plant Science Department at South Dakota State University, estimates that since 1968 interseeding has improved about 10,000 acres of pastureland each year in the state.

Union County, for instance, in the extreme southeastern part of the state is generally not thought of as "grazing" country—that type of farmland is farther to the north and west. But, the county agent points out, Union County has some 30,000 acres of pasture, some of it hilly as in the Alcester area, some in river bottom land. "There's a lot of new interest down here in cow-calf operations, most farmers looking for a situation whereby carrying capacity averages a cow and calf per acre for a 5-month period," Norby adds.

Research has been underway several years over a wide South Dakota area on varieties of alfalfas and grasses best for interseeding, how and when to plant, indications of returns that can be expected, and design of machinery to do the interseeding job. Fertilizer studies are currently underway. Properly done and managed, interseeding with legumes sparks new life into overgrazed or otherwise rundown pastures, SDSU researchers have found. Backing them up are Extension agents out in the field who see and hear farmer's reactions to interseeding.

Thousands of Acres Involved

Fred Morris, Codington County Extension agent, says interseeding should have a place on much of the 90,000 acres of native grass land in that county. Taking South Dakota as a whole, interseeding involves

Spring-planted Travois growing in an interseeded row in the fall.

This Travois was planted in the fall of 1970, about 3 weeks before the photo was taken.

Charles Norby (left), Union County Extension agent, and Harold Dailey look over a river bottom pasture that Dailey interseeded in May of 1969, about 16 miles southeast of Elk Point. Dailey, who is satisfied with results of his interseeding trial, is considering building his own interseeder.

potential improvement of hundreds of thousands of acres of grassland. Farmers in nearby states are also interested, say county agents who receive calls as well as visitors seeking additional information.

One of the biggest boosters for pasture improvement by interseeding—also called sod-seeding—is Dr. Moore who has been conducting research the past several years at the Pasture Research Center near Norbeck in Faulk County and elsewhere. "I'm convinced that no other single pasture improvement practice offers such potential for increased income as interseeding," he says. "We've found about what is needed and developed a method and equipment for getting it done. It works very well at Norbeck and for several central and eastern South Dakota ranchers who are cooperating with us." Risky? "Not any more than with other crops if basic good farming practices are used," Dr. Moore answers.

Travois alfalfa growing in a row interseeded a year previously on the Harold Dailey farm southeast of Elk Point.

Interseeding in established pastures, in early spring or fall, involves cutting furrows 4-6 inches wide, 1½-2 inches deep, some 2-3 feet apart, and placing seed no more than a half inch deep. The furrows help the new plantings get a start by reducing competition from established grasses.

Lack of Equipment

One major difficulty is getting machinery to do the job. These implements are not manufactured by any one firm, the Union County agent points out. It would hardly pay an individual farmer to own

(Continued on page 10)

A Travois-intermediate wheatgrass mixture planted in the fall of 1970.

County Agent Norby and Edwin A. Dowding of the SDSU Agricultural Engineering Department, check interseeding furrows made about 3 weeks previously.

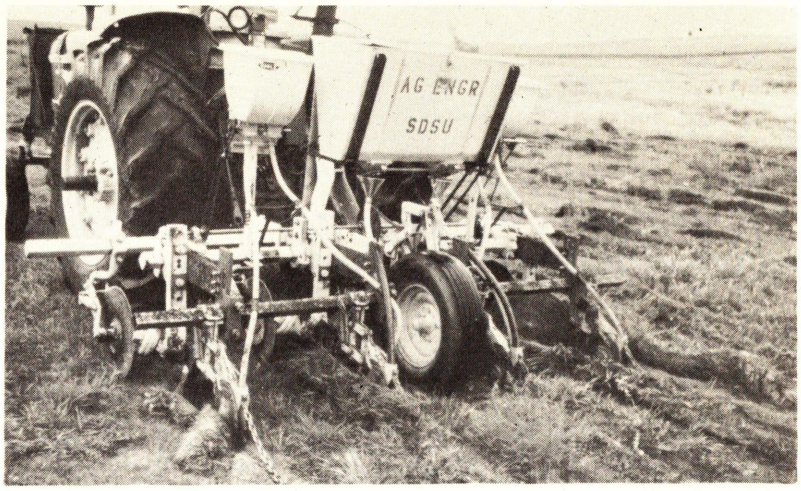
(INTERSEEDING—from page 9)

one because he would not likely use it more than once on the same land. But on a county-wide basis there's an overflow demand for interseeders which have been developed cooperatively. Norby was able to borrow an implement designed and built from commercially available parts by agricultural engineers at SDSU. "We found some 'bugs' in this machine, a few of which we corrected on the spot and the others the engineers will work on," he adds.

In Codington County, Extension Agent Morris designed an interseeder with parts from a milking machine and other types of seeders —even using some parts from an old Buick automobile. Other machines, some of which are made available to counties on a cooperative basis, have been developed by farmers, Soil Conservation Service districts, machinery dealers and "on the spot" at Norbeck. Engineers and agronomists working with the machines feel that some of the best and most practical design ideas will come from farmers themselves. SCS and other organizations also cooperate by furnishing equipment and technical help in recommending species for particular planting sites.

Alfalfa Usually Interseeded

Alfalfa or an alfalfa-grass combination is usually planted in the furrows stripped into the sod although in one western South Dakota study biennial sweetclover was used and maintained an adequate stand during a 5-year study. Most worn down pastures show a lack of native legumes so introduction of alfalfa is attempted to provide additional forage as well as a nitrogen-producing plant that improves growth of grass. Research shows that mixtures of either sweetclover or alfalfa with grass produce more forage than with grass alone. Furthermore, protein content of grass grown in mixtures with legumes is higher than when grown in pure stands. Two creeper or lateral root extension types of pasture alfalfas are most commonly used in South Dakota. These are Travois and Rambler. The crown spreading pasture type, Teton, is also widely and successfully used.



This pasture interseeder built by agricultural engineers at the SDSU Agricultural Experiment Station was first used in the spring of 1970 in Union County. Several other machines have been made and used in central South Dakota. Because an interseeder is used by an individual farmer only about once every 10 years, the equipment is generally operated on a cooperative basis by a number of farmers in a county.

Besides need for additional machinery, Norby lists difficulty of getting seed as another frequent problem. Seeding rate is about 1½ pounds an acre. "We started looking for seed several months early and were able to order 300 pounds in January of 1970," he says. "We had about 375 acres lined up for 1970 and planted about 162 acres in the spring before rains, machinery repair and then other farm work interrupted our schedule. Two of our best 'show places' total 15 acres seeded in 1969 which had hardy strips of alfalfa growing last spring with a profusion of grass."

Farmers, researchers and Extension people alike point out that interseeding has benefits in addition to boosting pasture production. Done on the contour, the furrows help conserve moisture, lessen pollutive factors caused by silt from soil erosion. Another point raised by Norby is that in Union County many of the acres now in corn or soybeans should really be in grass. "Maybe by giving worn out pastures a new look plus higher productivity, some farmers will decide to put part of their land back in grass," he suggests.

Keys to Success

Dr. Moore sums up these general suggestions for farmers considering interseeding:

"Pastures that need interseeding are the low producing kind usually full of weeds. Use herbicides to kill weeds before interseeding.

"Furrows are usually 2 to 3 feet apart, depending somewhat on condition of the pasture, and 1½-2 inches deep. Pastures in poor condition benefit from the closer spacing. Keep on the contour.

"Begin interseeding early in the spring as soon as the snow is off. Plan to finish no later than the third week in May.

"Moisture is probably the main factor relating to stand establishment. Best stands have been obtained on low areas, along streams, draws, and lower edges of slopes where there was some runoff. Moisture is also important in that it is necessary to make a desirable furrow for either spring or fall interseeding.

"Another factor is composition of original vegetation—best stands being obtained in an association of Kentucky bluegrass, blue grama and western wheatgrass.

"Some interseeding implements displace chunks of sod at the sides of the furrows. We've found these accumulations of roots, grass and soil are soon weathered away and cause no problem other than the initial shock as the farmer looks over his newly interseeded field.

"Cost of interseeding in a study in seven central South Dakota counties ranged from $6.00 to $8.50 an acre."□

Tree Planting by Chemical Fallow

By
Paul E. Collins, associate professor, and
G. L. Jensen, former assistant in forestry,
Horticulture-Forestry Department

SUMMER FALLOW is a commonly accepted practice for tree planting in South Dakota, especially if the site is pasture land or alfalfa. However, when tree planting is planned on steep slopes, conventional fallow methods could well result in excessive soil erosion and consequent degradation of the site. On these sites the practice of planting conifers in furrows has been used. Success or failure of these plantings has depended upon the availability of soil moisture at the time of planting, the timeliness of precipitation during the growing season and the technique used in handling and planting the trees.

A chemical fallow study was made by the Horticulture-Forestry Department at South Dakota State University in cooperation with U. S. Corps of Engineers to determine if such a technique might increase the store of soil moisture for tree planting on steep slopes. The plots were established on land controlled by the U. S. Corps of Engineers along the shores of Big Bend Reservoir (Lake Sharpe).

Study Areas

One study area was in the North Shore Recreation Area near Big Bend dam on the left bank of Lake Sharpe. Plots were laid out on a steep south-facing slope adjacent to the lake. The soil is a silt loam over a sandy substratum. Vegetation cover was typical for rangeland, primarily western wheatgrass and blue grama.

The other study area was in the Narrows area north of Lower Brule on the right bank of Lake Sharpe. Here the study site was on a steep east-facing slope having a silty clay texture over a clayey subsoil. Vegetative cover was native range plants, similar to that on the North Shore.

Chemical Treatments

The plots were laid out on six contour strips approximately 10 feet apart. Chemical fallow was compared with grass plots in three replications. Fallow was accomplished by treating 5-foot strips with a mixture of dalapon and simazine. Dalapon at 5 lbs/acre and simazine at 10 lbs/acre were applied the last week of April. A second application at 5 lbs/acre of dalapon was applied the first week of June to control warm season grasses.

Neutron probe access tubes were inserted in both treatments for moisture determinations. Bi-monthly readings were taken at the midpoint of each 1-foot interval with the first reading taken at a depth of 6 inches. Soil samples of the study areas were tested for moisture holding properties by the pressure membrane apparatus at the USDA Soils Laboratory at Madison, S. D. Soil samples were taken down to the 4-foot level on the North Shore and to the 5-foot level on the Narrows.

Study Results

The soil moisture readings through the growing season (7 dates) and a final reading in December for the two study areas are shown in Figure 1. In both study areas the fallowed plots showed an advantage through the growing season. More than 4 inches of rain in September narrowed the differences and, since the grass had cured by that time, both treatments retained a relatively good supply of moisture into December. The most marked difference was in the 1 to 2 foot level. At this depth the fallowed plots showed much greater soil moisture build-up than the grass plots. Fallow plots did store soil moisture which would increase chances for successful tree establishment the following spring.

The 15 atmosphere tension level shown in Figure 1 for the top foot of soil was determined by the pressure membrane method at the Madison USDA Soils Laboratory. This value represents the lower limit of available water for plant growth. As a soil dries out, roots

(Continued on page 12)

(TREE PLANTING—from page 11)

must exert greater tension to extract soil water. Finally a point is reached where root tension is counterbalanced by soil tension, and no water enters the root. This is called the permanent wilting point. Most plants have a permanent wilting point at a tension of 15 atmospheres.

It is significant that in both study areas, range vegetation drew soil moisture down below the 15 atmosphere tension value. Eastern redcedar and ponderosa pine have also shown this capability which may account for their drought-resistant qualities.

The accompanying table summarizes eight moisture sampling dates for all soil levels.

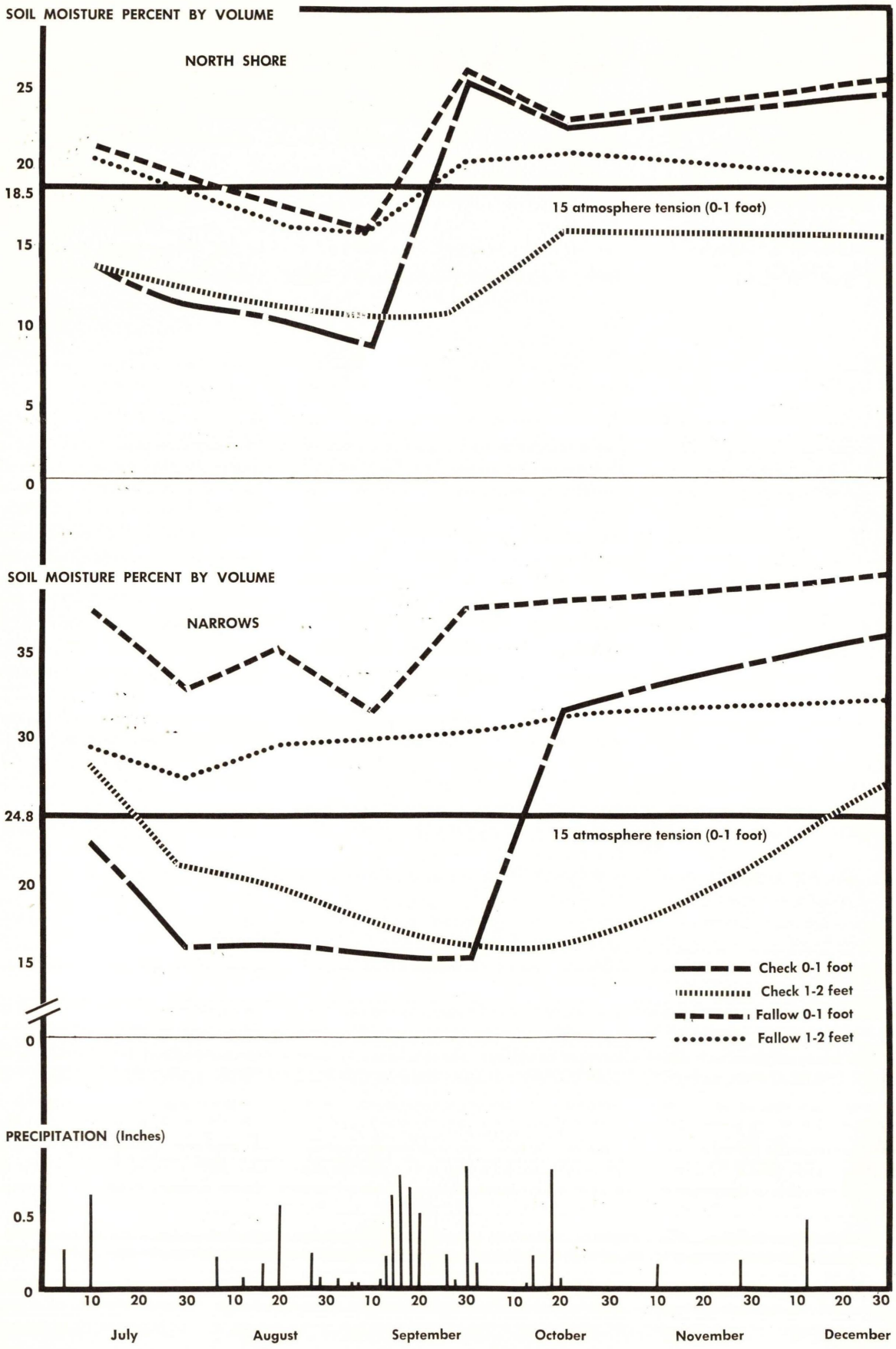
The wilting point values clearly indicate differences in the nature of soils in the two sites. In the Narrows the soil became progressively heavier and, in this sample, the soil moisture content remained below the wilting point throughout the growing season in the lower soil levels. This suggests a rather inhospitable soil for tree planting. In the North Shore, the soil became progressively lighter and moisture penetrated to the lower levels. The North Shore area moisture increased in the fallow plots over the grass plots down to the 3-foot depth.

The chemical fallow technique appears to offer a better tree planting site than furrowing in sod because of the more favorable moisture conditions. In addition, the killing of the grass and consequent partial rotting of the grass roots suggests an improvement of the site for the actual tree planting operation itself whether by hand or by machine planting. At the same time the dead tops act to protect the soil from erosion and excessive evaporation.□

Soil Depth	Moisture Percent by Volume 0-1	1-2	2-3	3-4	4-5
Narrows					
Chemical fallow	35.4	29.6	27.8	30.3	29.3
Grass check	23.6	22.1	24.9	26.7	28.6
Wilting point	24.3	33.8	39.8	42.6	46.3
Percent increase due to fallow	50.0	33.9	11.6	13.9	2.4
North Shore					
Chemical fallow	20.1	18.3	17.2	11.2	10.7
Grass check	15.0	11.9	11.5	10.4	10.7
Wilting point	18.5	17.5	12.7	9.2	0
Percent increase due to fallow	34.0	53.8	49.6	7.7	0

Figure 1. Soil moisture at two soil depths in the North Shore and Narrows study areas during the 1965 growing season. Soil moisture is expressed in terms of percent volume and compares chemical fallow plots with grass plots.

Testing soil moisture in a 5-foot chemically fallowed strip with a neutron probe.


SOIL MOISTURE PERCENT BY VOLUME
NORTH SHORE
25
20
18.5
15
10
5
0
15 atmosphere tension (0-1 foot)
SOIL MOISTURE PERCENT BY VOLUME
NARROWS
35
30
24.8
20
15
0
15 atmosphere tension (0-1 foot)
Check 0-1 foot
Check 1-2 feet
Fallow 0-1 foot
Fallow 1-2 feet
PRECIPITATION (Inches)
0.5
0
10 20 30 10 20 30 10 20 30 10 20 30 10 20 30 10 20 30
July
August
September
October
November
December

Southern Corn Leaf Blight

By
C. M. Nagel, professor of plant pathology,
Plant Science Department

In 1970, southern corn blight made news headlines and began a scare that corn and, therefore, beef and pork might be in short supply this winter.

In spite of the losses, estimated now at 15% nationwide, there should be no severe shortage because this year's corn harvest, estimated at 4.1 billion bushels, will be the third largest in our history because of the favorable growing conditions in the Corn Belt. However, if blight continues to be a major disease on corn, shortages could occur rapidly and the national economy could be severely jolted.

Southern corn leaf blight (SCLB) was present in light amounts on corn in South Dakota from the Nebraska to the North Dakota borders in the two tiers of counties along the eastern border of South Dakota.

The yield loss for the state would amount to less than 1%.

The symptoms of this disease consist of spots on the leaves, leaf sheaths, and husks, rot of ear shanks and ears. If the disease becomes severe and defoliation occurs, other diseases affecting the plant, such as stalk and root rot, become more destructive.

What Was the Cause?

What was the cause and what steps are being taken to guard against similar damage in the future?

The cause was the southern corn leaf blight fungus, a new strain of an old fungus which has been present in the Southern States for 25 years, and scientifically known as *Helminthosporium maydis*. Blighted corn looks spotted and scorched as though killed by an early frost. The diseased lesions produce spores or "seed" abundantly on the surface and are spread by wind, rain, and seed. It remains to be determined if the SCLB fungus will survive the winter conditions in South Dakota or in much of the rest of the Corn Belt. This new strain of the fungus, which was created recently in nature, has been isolated by plant pathologists in the laboratories of Corn Belt agricultural experiment stations during the past year. There has not been enough time to obtain necessary information concerning the new strain of this serious plant disease organism to answer many of the questions regarding its effective control. Experiments are under way in many state Agricultural Experiment Stations to this end.

Control Procedures

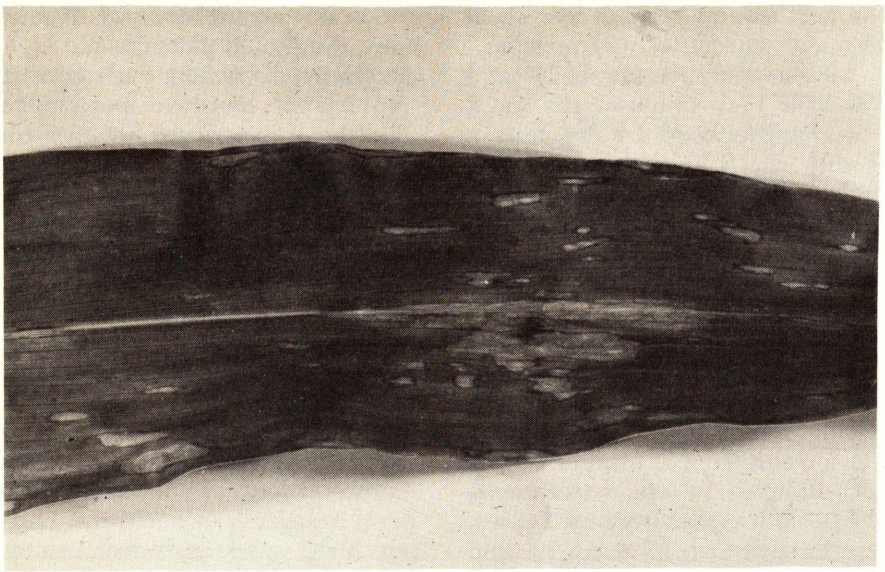
Present knowledge regarding control measures for this disease include:

- Growers should try to obtain seed corn produced from seed fields which have been detasseled by hand. Hybrid seed produced with male sterile or with T *cytoplasm* is highly susceptible. *Normal cytoplasm*-produced seed is highly resistant although not immune to the T strain of the southern corn blight fungus.
- Carefully chop and plow down harvested corn fields so as to cover up as much of the leaves, stalks, and other refuse from the crop as possible. This will help reduce the source of fungus inoculum in the spring which, if the organism survives the winter, can spread to the new corn crop.
- Barley, oats or wheat is not susceptible to southern corn leaf blight.
- Hybrid seed corn blends on the market consist of mechanical mixtures of male sterile and male fertile produced seed. Blends will have limited value in controlling the disease and may create problems at harvest time, especially if blight becomes serious in 1971. Most hybrid seed corn producers will have "blend" information printed on the seed corn bags.
- Conditions of minimum tillage would tend to increase the amount of damage from southern corn leaf blight by increasing fungus inoculum on grass weeds.
- Seed treatment with the fungicide Captan will benefit by reducing the amount of inoculum.
- For the future, hybrids based on S and other resistant but male sterile cytoplasms are being made and tested.
- Southern state agricultural experiment stations, first to encounter this disease problem, have conducted feeding experiments and results show no toxic effects from diseased corn when fed to livestock.

Also Two Others

Two other fungi also cause leaf blight and may be confused with southern corn leaf blight in the field. Northern corn leaf blight is caused by *Helminthosporium turcicum*, a minor problem readily controlled with resistant hybrids, and yellow leaf blight (a new disease threat) caused by still a different fungus, *Phyllosticta zeae*, which first began to damage corn in northern states in 1968. Symptons of the three diseases are quite similar and therefore are difficult to identify in the field. Laboratory diagnosis is necessary. All three fungi have been isolated from disease lesions in South Dakota corn.

Weather conditions for spread and development of leaf blight in 1970 were at times favorable. However, we do know that the genetic make-up of the corn itself grown in South Dakota was a major factor



Southern corn leaf blight symptoms. Elongated tan spots may appear singly or in groups. When spots become abundant, leaf will be killed within a few days. Infected leaf collected at New Effington, S. D., August, 1970.

in permitting the disease to infest the corn crop. The hybrid corn grown in South Dakota was largely T cytoplasm or male sterile, which is highly susceptible. This arises from current practice in hybrid seed production of using male sterile cytoplasm to avoid the expense of hand detasseling.

Until the last 15-20 years virtually all hybrid seed corn was produced by hand detasseling—removing the male elements or tassel in a seed field (i.e., the pollen) so that the seed parent was not self-pollinated. At the peak of the detasseling season the job occupied an estimated 135,000 people nationwide. It was the most expensive part of raising hybrid seed corn.

Find Detasselling Substitute

A search for the genetic substitute for detasselling began. The late Donald F. Jones of the Conneticut Agricultural Experiment Station and Dr. Paul Mangelsdorf, formerly of the Texas Agricultural Experiment Station, were the first to show how to use a corn strain with naturally sterile pollen. This is called cytoplasmic male sterility. A cytoplasmic character is transmitted by the mother plant to all its progeny. The cytoplasmic male sterility character was introduced by crossing an inbred to the sterile source, crossing the hybrid back to the inbred and repeating the backcross in each successive generation. A hybrid, made up with "sterile cytoplasm," was fertile because of the action of the restorer genes from the male parent.

About 15 years ago, this system was introduced into the hybrid corn seed production program and has become widely adopted. In recent years about 80% of commercial hybrids were made up with the T cytoplasmic male sterility. The wide use of T rather than other sources of sterile cytoplasm came about because it worked better under varying environmental conditions in the field.

Problem Noted in 1961

The first indications that a problem was in the offing were noted in research results published in 1961 at the Central Experiment Station in the Philippines. It was found that T cytoplasmic male sterile corn inbreds and hybrids were much more susceptible to the southern corn leaf blight disease than those with normal cytoplasm. In fact, the Philippine publication and another confirming it published in 1965, are the first descriptions of the cytoplasmic inheritance of disease susceptibility in a crop plant.

A check in 1963 with inoculations of strains of *Helminthosporium maydis* from Illinois showed no difference in disease reaction between the male sterile and normal corn lines used in the Philippines. The same was true of similar tests made later in Pennsylvania. However, in 1969 heavy infection was observed in corn with T cytoplasm in southern Iowa, Indiana, and Illinois. In 1970, corn grown in Florida became infected with *H. maydis* and rapidly spread to the north, into the Corn Belt, and also into Ontario, Canada. A new race of the fungus had developed specifically adapted to corn carrying the T cytoplasm.

In 1969 it was reported that high susceptibility to yellow leaf spot is also associated with T male sterile cytoplasm. Although plant scientists had produced a wide spectrum of different corn hybrids with considerable genetic diversity they had overlooked the fact that these hybrids were nearly uniform with respect to their cytoplasms. Thus, with favorable weather conditions there was rapid spread of the new strain of a virulent pathogen which is readily adapted to its host, the corn plant.

Short-Term Cure Simple

The short-term cure is simple: do not use hybrids made up with T cytoplasm. Normal cytoplasm is highly resistant to the T race. Available for the 1971 corn planting season is about 3 million bushels of hybrid seed produced by the fertile male method made by hand detasselling. This amount will plant only about 15%-20% of the total national requirement. Much of this will go to major corn states where the risks are greater because of SCLB. Most farmers will have to grow T cytoplasm corn next year because only this is available in large quantities. Also, some hybrids are being put out as blends with up to 50% seed with normal cytoplasm for pollination. Most seed producers have labeled their hybrid seed blends on the bags stating its percentage of T cytoplasm (the susceptible type).

Fungicides for the control of blight on fields used for seed production will perhaps be available for 1971. However, the effectiveness is not as good as desired, hence the control may not be economically feasible. Applications will need to be made several times during the growing season.□

Heated Corn, Cooled Alfalfa

RESEARCH to boost crop yields by manipulating soil and air temperatures may someday help expand the Corn Belt and put a potential water pollutant to work.

South Dakota State University researchers now report some preliminary results of experiments at the Southeast South Dakota Experiment Farm southeast of Centerville. Last summer's experimental plots showed increases in corn growth where electric cables were used to *heat* the soil. In contrast, only 30 yards away an attempt was being made to increase alfalfa yields with special sunshades and mulches used to *cool* the air and soil. The experimental plots were monitored by automatic devices to continuously record soil and air temperatures.

But don't expect to see farmers using heat grids in corn fields and sunshades over alfalfa fields within the next few years, although preliminary observations indicate some yield benefits from these man-made alterations to plant environment.

Gaining More Knowledge

Mulches, heat cables and sunshades of cheesecloth and tinted plexiglass are research tools being used to gain more information about relationships between environmental temperatures and plant growth in corn and alfalfa, according to Paul D. Evenson, research agronomist with the Agricultural Experiment Station at SDSU. "Once these relationships are understood, practical solutions for use by the farmer in his field can be devised through manipulation of the environment, the plant, or both," he says. "The practical aspects of this research—for the next several years at least—will be mainly concerned with mulches."

Alfalfa yield increases of 10% and 17% have been obtained the last 2 years at Brookings by mulching a freshly cut field with straw. The mulch lowered temperatures at plant crown depth (about 1 inch deep) by as much as 17 degrees and appeared to have a beneficial effect on soil moisture content.

In the Centerville research, cubed polystyrene and straw were both used as mulches immediately following first cutting of alfalfa when the soil surface was exposed to direct sunlight. In other treatments cheesecloth shades were used to lessen intensity of all sunlight, and plexiglass shades were used to cut out only heat-ray type solar energy not used by the plant. Also included in the alfalfa research are various fertilizer treatments including phosphorus, potassium, nitrogen and trace elements.

Three Temperature Levels

Three temperature levels were established with and without starter fertilizer in the corn experiment. Cool soil temperatures were obtained with the straw and polystyrene mulches. Warm temperatures were provided by heat cables buried 5 inches below the corn rows and thermostatically controlled to keep temperatures from falling below 80 degrees. One set of heated, fertilized plots was covered with mulch to help reduce evaporation of soil moisture. The third level consisted of temperatures normally experienced during the growing season. Starter fertilizer was applied at the rate of 90 pounds per acre of 8-32-16 (8-14-13 elemental). A blanket application of 80 pounds of nitrogen an acre was made on the experiment.

Treatments with greatest early season growth (Figure 1) also matured first and produced the largest yields (Figure 2).

Heated Plots Yield Highest

The mulched plots without heat tapes produced the lowest yields, had the slowest early growth and the highest ear moisture percentage at harvest, according to Evenson in reviewing first year results. High ear moisture percentage is an indication of delayed maturity. In contrast, the heated plots yielded highest, showed greatest early growth and lowest moisture percentage. The check plots were between the mulched and heated plots with respect to these factors.

"Mulch tends to reduce evaporation of soil moisture while heat increases evaporation of soil moisture," Evenson adds. Therefore, the response to soil temperature would actually be greater than shown by the first six bars in Figure 2 because of moisture lost under heated plots and moisture saved under the mulched plots. This is brought out by the seventh bar on the chart which represents yield from heated plots covered with mulch.

"This treatment increased yield over the non-mulched heated plots by 20 bushels per acre—86 bushels less 66 bushels," he says. "The increase over the check plots was 23 bushels, and the increase over the mulched plots was 29 bushels."

Starter fertilizer response appeared to be about the same in all temperature treatments. These responses ranged from 9 to 12 bushels per acre. However, the yields from this experiment were generally quite low as a result of inadequate rainfall. Results from previous research indicate that temperature treatments would have a greater influence on yields at higher soil moisture levels. Temperature might have more influence on starter fertilizer response at higher moisture levels.

Installing heat cables.

Cooperating with Project Leader **Paul D. Evenson** in this research are: **Melvin D. Rumbaugh** and **Fred E. Shubeck,** professors in the Plant Science Department; **Burton E. Lawrence,** assistant superintendent of the SESD Experiment Farm; and **Dwight Hovland,** former associate professor in plant science, who began the alfalfa phase of the experiments near Centerville.

Possible Implications

This experiment shows, the agronomist explains, that adequate amounts of heat and fertilizer are required to maximize corn yields. It also demonstrates the value of mulch in retaining soil moisture for plant growth.

If the Corn Belt is to be moved to the north and west, the problems arising from lack of soil heat must be overcome, he adds. There are several approaches to these problems. For instance, one approach might be through breeding and selecting varieties that grow under cool temperature conditions. Another approach would be to study the biochemistry of the plant and determine the imbalance of growth regulating substances during these cool periods. Thus, in the future, the farmer might spray synthetic growth regulators on his corn to make it grow under cool conditions.

"Additionally, a heat source which fits into the economics of such a situation might be available," he concludes. "As a long-term projection, there's the possibility of obtaining heat from water used as a cooling agent in generating electric power and in manufacturing plants, provided industrial expansion becomes as great as some forecasts indicate. The idea is that the heated water would be recycled to extract the heat or energy for use in fields before it is returned to bodies of water where it could otherwise cause thermal pollution.□

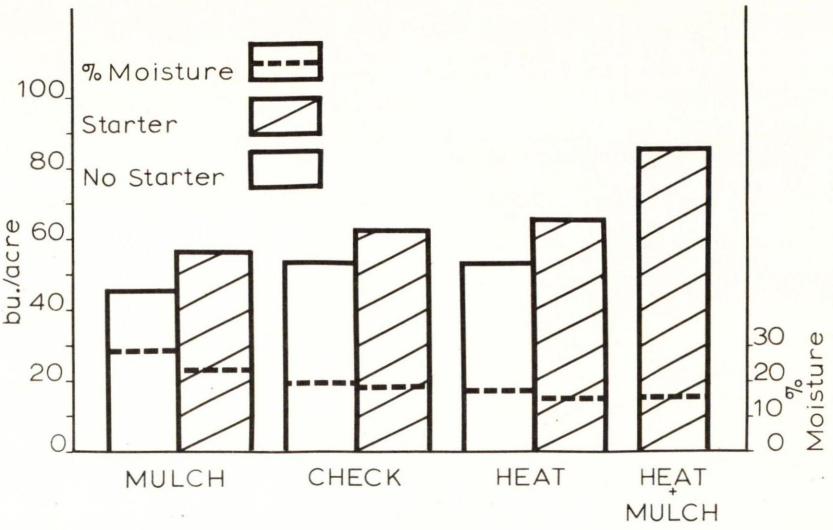
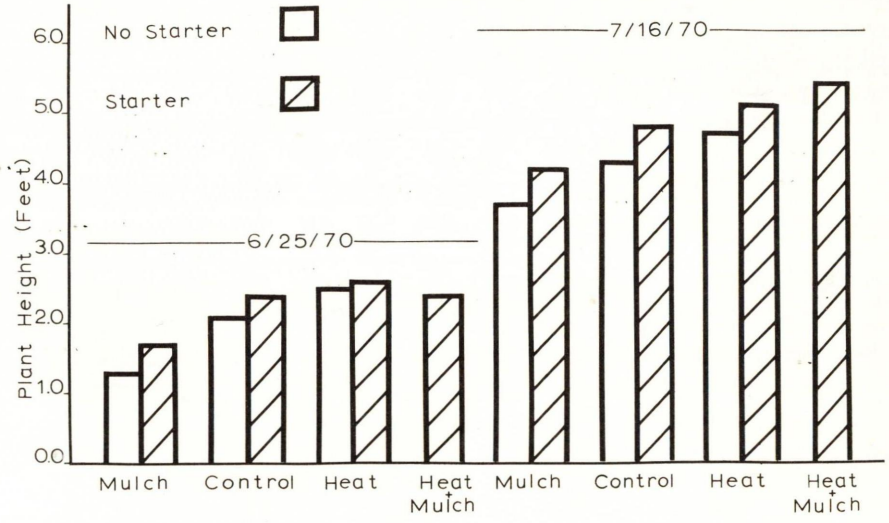
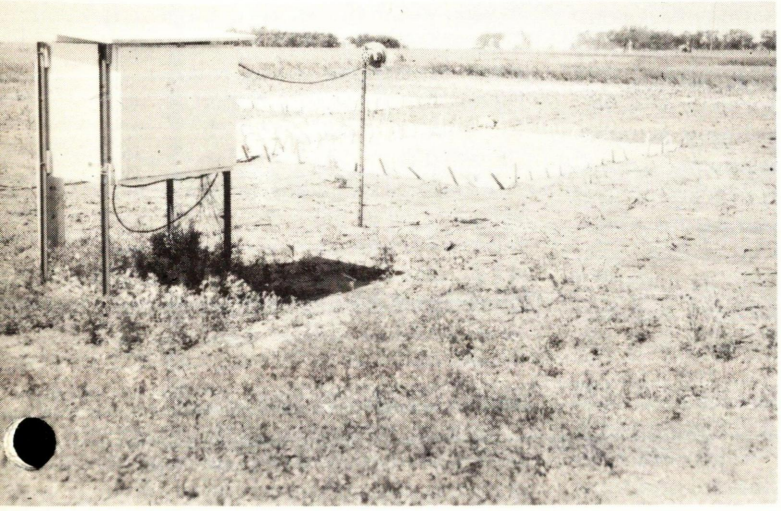


Figure 1. Plant heights at two periods during the season as influenced by starter fertilizer, mulch and heat.

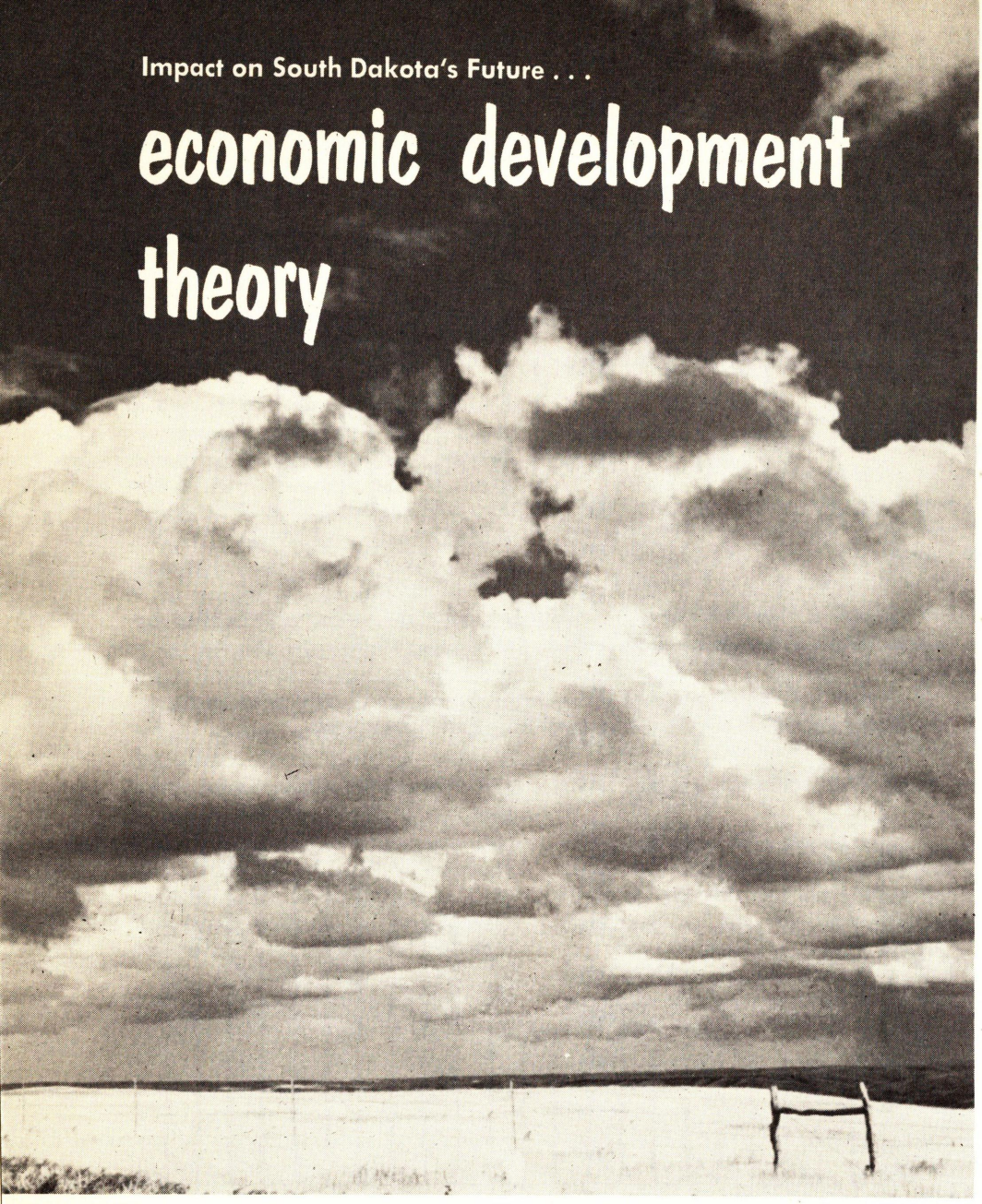
Figure 2. Yield of corn and ear moistrue percentage as influenced by starter fertilizer (90 pounds of 8-32-16) and soil temperature treatments.



Recording-control equipment housing (left), plots beyond.



As season advances, note growth differences (upper left). Polystyrene mulch shows between rows (center).



Impact on South Dakota's Future . . .

economic development theory

By
J. E. Wiebe, assistant professor, Economics Department, South Dakota State University.

Development of South Dakota's strong points must be emphasized to "meet the competition" in the future. In this article, Dr. J. E. Wiebe of the SDSU Economics Department, suggests that South Dakota resources of space and an ample supply of relatively clean air and water be developed according to a policy or plan.

THE PROCESS of economic development of a region is difficult to understand unless a theory exists to explain it. The explanation of economic development is accomplished by theory through the advancement of knowledge of relationships of different elements or conditions associated with the development. Knowledge of economic development is promoted through numerous observations of similar occurrences under similar conditions over an extended period. In this way theory summarizes existing knowledge and explains why observed events occurred. Theory can then be used as a basis for predicting the occurrence of yet unobserved events and relationships under similar conditions but on different occasions or locations.[1]

It is the object here to examine regional economic development from a theoretical approach and, considering this theory, to examine economic development trends and potential for South Dakota.

Regional Development in Theory

A theory which explains the process of regional economic development is the export base theory. This theory maintains that development of a region has typically been promoted by the ability of a region to produce goods and services demanded by the national economy and to export them at a competitive advantage with respect to other regions. The economic development of a region is commonly thought of as a discernible rise in total and per capita income of a population, widely diffused throughout occupational groups and continuing long enough to be cumulative.[2] The export base is important in that it plays a primary role in determining the level of aggregate and per capita income of a region. As a region's income grows, saving and investment will tend to spill over into new kinds of economic activities.[3]

If the decline of one exportable commodity is not offset by the growth of others, economic growth of a region will slow down or perhaps even stop. Among the main reasons for the decline of an exportable commodity have been changes in demand outside the region, such as the decline in the demand for beaver hats which affected the fur trade; exhaustion of a natural resource as in the case of the Great Lakes lumber industry; increasing costs of land or labor relative to those of a competing region, as was the case in the shift of the textile industry from New England to the Southern States; and technological innovations as occurred in the steel industry where the extensive use of scrap may justify small-scale steel production as a local industry whenever the local market achieves sufficient size.[4]

Regional Resource Endowment

Closely associated with the export base theory is the concept of regional resource endowment. This

concept varies by regions and is difficult to define in any long-run sense. In the short-run, endowment is simply the inventory of those natural materials required to meet national demands. As the requirements of the economy change, the resources utilized change. In this sense resource endowment is a changing concept closely associated with the dynamics of economic growth. In short, the answer to what constitutes resource endowment is determined by final demand and in the organization and technology of production. As these two conditions change, so will the content of resource endowment. As the composition of resource endowment changes, there will often be changes in the relative advantages among regions supplying material inputs and services for the national economy. This situation occurred in the early agricultural period prior to 1840 when the American economy developed as a producer of resource inputs for the rapidly expanding European economy. Arable land, climate and water together with access to the growing European market for agriculture staples, contributed to the conditions instrumental in regional growth of American regions.

An example of a similar situation was the minerals-dominant economy in the last half of the 19th and first half of the 20th centuries. The rapid growth of the railroads and the expansion of processing industries resulted in requirements of new inputs, particularly iron, steel and coal.

The services era and amenity resources of recent decades are a further example of resource endowment and regional development. This effect was the result of a number of developments within the national economy and society. Included were the increasing importance of the nonjob-oriented as well as the job-seeking migrant, the growth in number and significance of industries whose ties to resource inputs and national market centers were relatively weak and the effect of a rising per capita income and an associated increase in tourism across the nation.[5]

South Dakota Trends, Potential

The economy of South Dakota has traditionally been, and remains, agriculturally oriented. This intensely specialized industry represents an important contributing sector of the economy evolving out of the forces of comparative advantage over the years. But most agricultural products rate low in their ability to promote regional growth. In recent decades the agricultural sector for the nation, when measured by an index of per capita agricultural production, has expanded at about the rate of population growth.

In general, the demand for agricultural products has not kept pace with increases in personal income. As a result, changes in agriculturally dominant regions have been tied to the irregular changes of national demand for products of that region. This has set at least ultimate limits to the region's growth rates as witnessed in the case of the tobacco and cotton producing areas of the South. The South had to resort to the production of crops other than tobacco and cotton in an attempt to maintain a viable agricultural economy as the demand for traditional Southern crops decreased relative to

(Continued on page 20)

[1]See, Henry Margenav, "What is a Theory," *The Structure of Economics Science*, ed. Shermann Roy Kaupp (New Jersey: Prentice-Hall, Inc., 1966), pp. 25-38; Richard G. Lipsey and Peter O. Steiner, *Economics* (New York: Harper & Row, 1966), pp. 19-23.

[2]Benjamin Higgins, *Economics Development* (New York: W. W. Norton and Company, Inc., 1959), p. 432.

[3]See, Douglas C. North, "Location Theory and Regional Economic Growth," *Regional Development and Planning*, ed. John Friedmann and William Alonso (Cambridge: The M.I.T. Press, 1965), pp. 240-255.

[4]*Ibid.*, p. 251.

[5]See, Harvey Perloff and Lowdon Wingo, Jr., "Natural Resources Endowment and Regional Economic Growth," *Regional Development and Planning*, pp. 215-239.

[6]*Ibid.*, pp. 226 & 233.

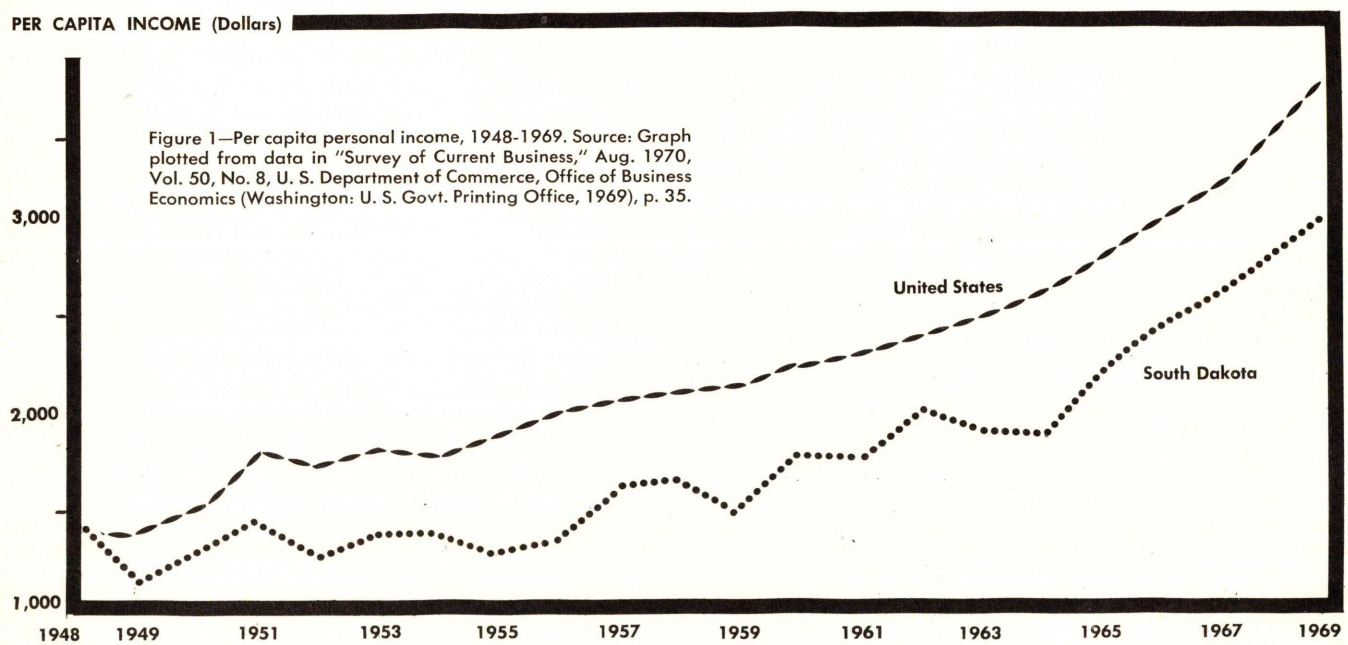


Figure 1—Per capita personal income, 1948-1969. Source: Graph plotted from data in "Survey of Current Business," Aug. 1970, Vol. 50, No. 8, U. S. Department of Commerce, Office of Business Economics (Washington: U. S. Govt. Printing Office, 1969), p. 35.

Roving Research Laboratory

A NEW, self-contained mobile laboratory packed into a converted camper trailer may provide both irrigation and non-irrigation farmers with information about how to conserve moisture, when to irrigate and how much water is needed at specific crop growth stages.

At a casual glance you could barely distinguish this mobile laboratory from scores of other camper trailers plying South Dakota highways last summer. But right there the similarity ends.

Inside the lab is an array of recorders, a data logger and sensitive instruments that provide data on air and soil temperatures, humidity, wind velocity, and solar radiation. When all of these factors are later compressed into definite relationships with a computer on the South Dakota State University campus, scientists translate them into practical knowledge that a farmer can use.

Greater Return on Investment

"The lab gives us a wider range plus, we think, a greater return on an investment in rather expensive research equipment," explains Maurice, L. Horton, associate professor in the Plant Science Department at SDSU. "For instance, we can spend a few days near Redfield getting data on irrigated sorghum. Then we can button down the whole works, haul it to Lake County and within a few hours have it rigged up to get data on mulched non-irrigated corn in experiments near Madison. We've got the same investment as we would have for a good fixed location but now we're able to get information about a greater variety of crops, cropping practices and differing climatic conditions."

Instrumentation and equipment —including a portable gasoline-powered generator to provide electricity—is specially anchored and

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economic development theory . . . (from page 19)

other products. A similar situation developed in the Plains States which increased their specialization in agriculture at the same time that their relative contribution to total national value of agriculture products was declining.[6] South Dakota is a part of this region.

Table 1. Average percentage change from year to year in per capita incomes, selected regions and states, 1929-60 and 1945-60

Region or State	1929-60	1945-60
Pacific Northwest	9.0	3.5
Great Lakes	9.8	5.3
Mideast	7.5	4.2
New England	7.2	4.5
Plains	9.8	5.5
United States	8.4	4.4
Washington	9.0	4.0
Oregon	8.9	4.2
Idaho	10.8	4.4
Montana	9.6	5.9
California	7.5	3.8
Michigan	10.9	5.6
Ohio	9.9	5.9
Illinois	9.4	5.3
Massachusetts	6.9	4.6
Pennsylvania	8.5	4.8
Oklahoma	10.1	5.0
Nebraska	11.6	7.0
Iowa	12.7	8.4
South Dakota	18.0	11.8

Source: Richard L. Pfister, "External Trade and Regional Growth: A Case Study of the Pacific Northwest," *Regional Development and Planning*, p. 295.

The results of an agriculturally dominant economy in South Dakota appears to be obvious. Per capita income in South Dakota has consistently been below the national level for the 1949-69 period as seen in Figure 1. Fluctuations in per capita income have also been greater for South Dakota than for the nation in the 1929-60 period as seen in Table 1. In the recent census South Dakota, together with an adjacent state, recorded a decrease in population. These trends are all too familiar to South Dakotans.

But trends and resource endowments can change. An insight emerging from an examination of the history of American economic development is, as mentioned earlier, the relative nature of resource endowments. It is not only important to recognize that the resource endowment of South Dakota is agriculturally oriented; it is perhaps equally important to be aware South Dakota is richly endowed with resources increasing in demand yet diminishing in supply at the national level. These resources are space and an ample supply of relatively clean air and water. The author would like to suggest that these three resources be guarded jealously by South Dakotans and developed for the benefit of the citizens of the State as well as the Nation. The policy required to attain this developmental goal is another issue.□

SUMMARY

The economic development of a region is closely associated with the national demand for resources of that region. This process of development is explained by theory and substantiated by practice.

The economy of South Dakota has traditionally been, and continues to be, agriculturally oriented at a time when the relative demand for agricultural products at the national level is decreasing. As a result, development trends of the State have not kept up with those of the Nation.

South Dakota is endowed with resources increasing in demand on the national scene. These resources are space and an ample supply of relatively clean air and water.

Economic trends can be reversed and development theory would suggest that the economic future of South Dakota is bright. What is needed is policy that would develop the resources of South Dakota for which there is an increasing national demand.

Dr. Maurice L. Horton, who discusses here a new mobile laboratory used in Agricultural Experiment Station research last summer, will be returning soon from a special 6-months leave spent at the University of California at Davis. At Davis Dr. Horton had a teaching assignment to temporarily replace a staff member who is on leave, and, additionally, is doing research and special studies involving remote sensing techniques

protected during transport, adds the Agricultural Experiment Station agronomist. Instruments actually set up within the growing crop send signals over electric wires to the data logger and recorders in the trailer parked nearby. The unit is insured for $25,000.

Dr. Horton says calculations from field data provide information on short-term evaporation and differences in air and leaf temperatures in the crop canopy provide estimates of water stress—or how much moisture the crop needs at a particular time.

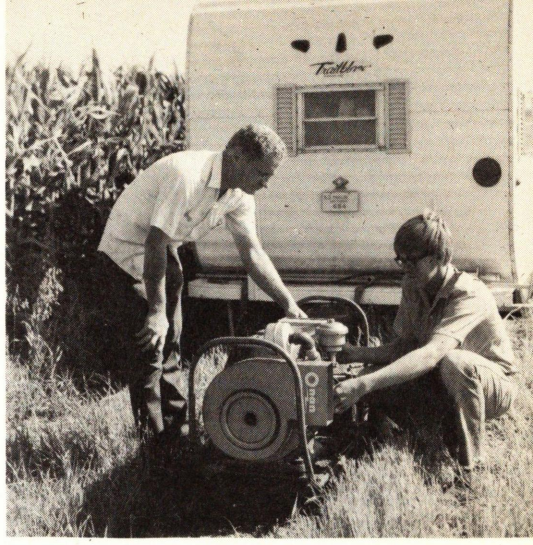
Cooperate with Remote Sensing

Newer aspects of the work include cooperation with the South Dakota Remote Sensing Institute which headquarters on the SDSU campus and with range scientists at Cottonwood in determining evaporation rates of native prairie grasses in range areas. Overflights were made by RSI aircraft at both Redfield and Cottonwood during the time the mobile laboratory was in operation at these places.

Victor I. Myers, RSI director, points out that the mobile lab can provide "ground truth" for thermal (or heat) "pictures" taken from aircraft. At some future time, data may become available to provide farmers with information on soil and plant conditions as related to irrigation or crop management.

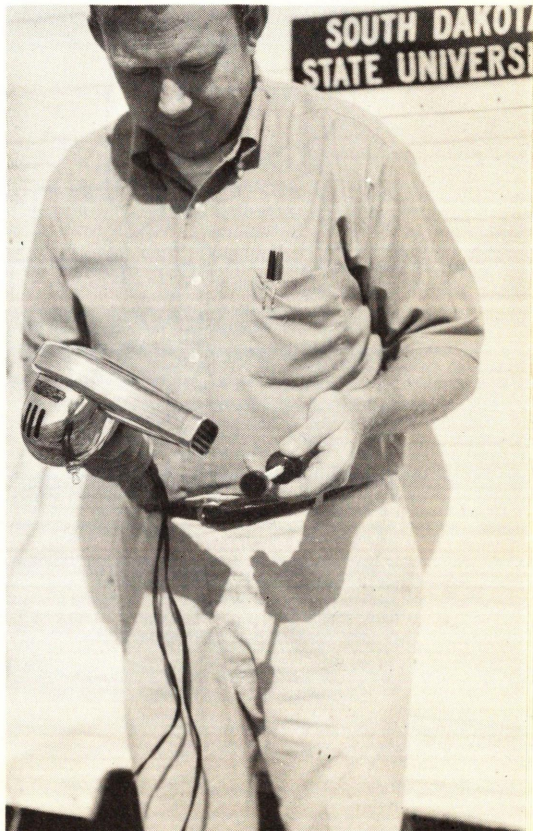
Attempts are being made at Madison in cooperation with USDA agronomist Tamlin C. Olson to learn more about what mulch does to the crop environment, Dr. Horton says. "We're able to detect differences in the microclimate between mulched and non-mulched situations. Mulching—the practice of using a crop residue as a soil cover—might be considered a type of 'weather modification' in the field."

Redfield research last summer was mainly with detection of soil and plant water needs of irrigated and non-irrigated sorghum at different stages throughout the growing season.□

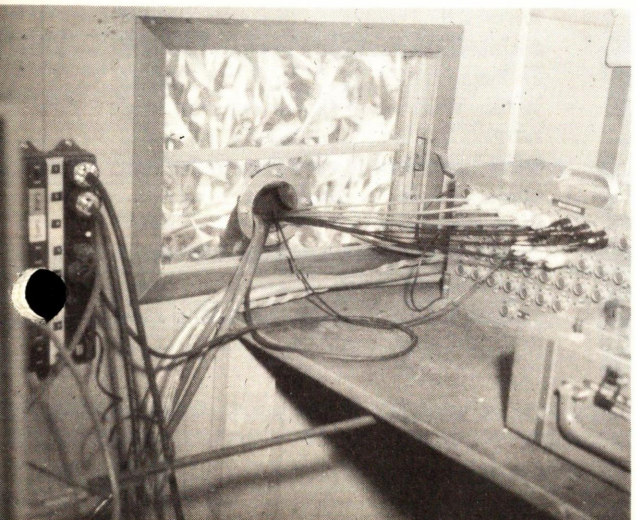


Rod Devine, Brookings, (left) and Ray Brende, Colman, adjust portable electric generator that powers instruments inside the camper trailer (background) which extends SDSU agricultural research field capabilities. Devine and Brende are SDSU students.

Maurice L. Horton, SDSU research agronomist, adjusts electrical cables leading from mobile lab (left) to instruments set up in the nearby field at ground level, within the crop canopy, and above the crop canopy.



What's a hair dryer doing in a lab concerned with getting technical data about climate and cropping practices? It is necessary to evaporate accumulations of moisture on a dew cell sensor used in measuring humidity.



Inside the mobile lab, cables from the field lead in through an access hole to connect with the input terminal box (right) of the data logger, partially shown at left, and other instruments.

The data logger automatically records humidity, temperatures, solar radiation, and heat flux. Data recorded on tape (note reels at bottom) is then processed by computer on the SDSU campus.

Farm Pond Winterkill

By
John G. Nickum, associate professor,
Department of Wildlife and Fisheries Sciences.

THERE USED to be fish in my pond, but a couple of years ago it winterkilled."

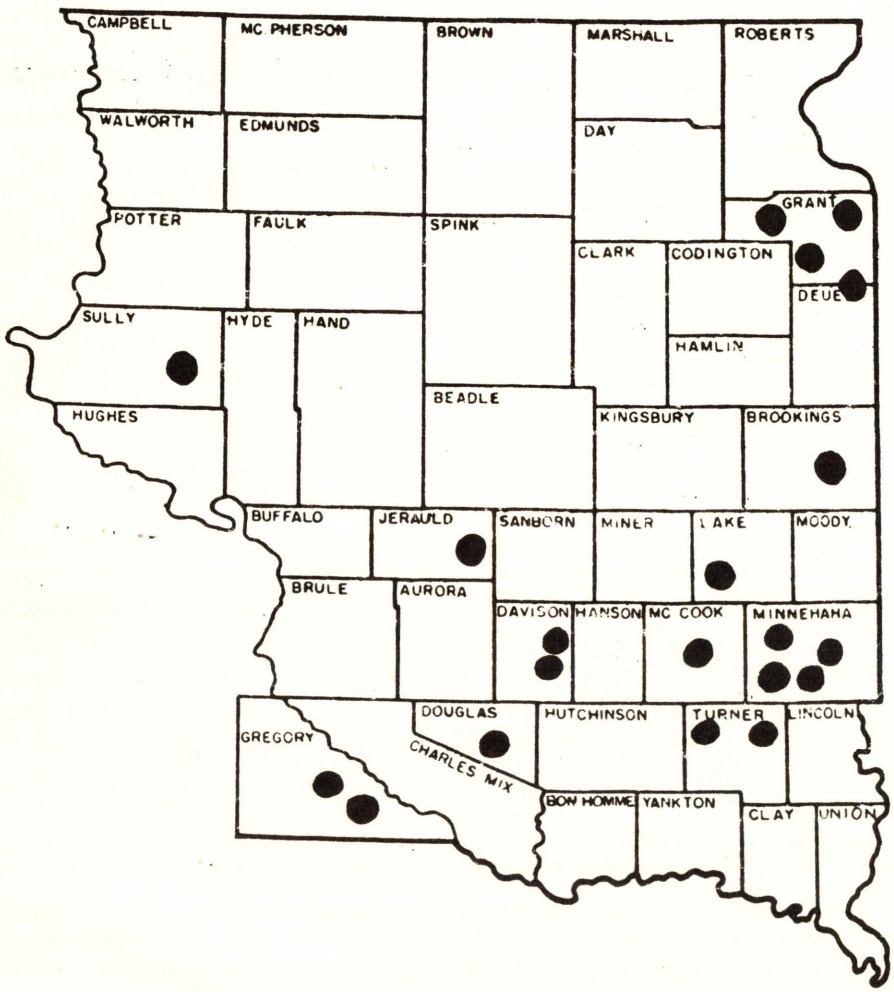
That statement is repeated again and again by pond owners throughout the Northern Plains area.

It is often followed by a question, "Why didn't my neighbor's pond freeze out that year too?"

Why ponds (and lakes, too) do or don't winterkill has interested investigators in the Wildlife and Fisheries Sciences Department at South Dakota State University for several years although no major research program is focused on the problem. We can provide answers explaining why ponds winterkill, but explaining why seemingly similar ponds have not winterkilled is more difficult.

Winterkill occurs when sunlight is shut out of ponds, due to either heavy snow cover or cloudy, milky ice. Without sunlight the algae and other green plants in the water cannot continue photosynthesis, the process by which they produce food and, as a by-product, oxygen. Oxygen from photosynthesis plus whatever oxygen was dissolved in the water when the pond froze over are the only sources of this element for all the living organisms in the pond.

●=Ponds which did not winterkill during 1968-69 (checked in the summer of 1969). All ponds checked were in response to requests for information concerning ponds which did not winterkill.



Oxygen Supply Important

When sunlight is shut out and oxygen production stopped, the oxygen supply starts to diminish. The rate at which it diminishes depends upon the total supply available in the pond and the demand or use for plant and animal respiration and for decay of dead organic matter. If respiratory and decomposition demands are low (due to low plant and animal populations) or if the total stored oxygen supply is great (usually due to water depths over 15 feet), a pond will not winterkill. Conversely, heavy growths of algae, other aquatic plants, and the animal life the plants feed, combined with shallowness, will almost always lead to winterkill.

Winterkill is caused not by low temperatures but by a shortage of oxygen resulting from a lack of sunlight sufficient for photosynthesis. Cold temperatures actually act to hold off winterkill by decreasing metabolism and decomposition and increasing oxygen holding capacity of water.

Winterkill in 1968-69

Heavy snow accumulations in eastern South Dakota during the winter of 1968-69 led to winterkill conditions in most farm ponds. During the summer of 1969 a brief study was made of ponds which did not winterkill in an attempt to determine which factors are most important to avoid it. Twenty ponds, situated throughout "eastern" South Dakota from St. Charles to Milbank, were examined. The ponds ranged in size from about 0.15 acres to 18 acres and from 8 feet to 20 feet in depth. Each pond and its watershed were inspected, measured for depth, and water samples taken for chemical analysis.

The results indicated that the following factors may be related to the

Recommendations

Recommendations for pond construction based on the observations in this study are:

- **Maximum depth of at least 15 feet.**
- **Locate pond on watershed with minimal cultivation.**
- **Exclude livestock from all but a small watering area.**
- **If possible, locate the pond so that prevailing winter winds blow along the length of the pond.**

absence of winterkill in various ponds: depth, productivity of the pondwater, use of watershed, exposure to winds, and presence of springs.

Each of these was the apparent main factor in preventing winterkill in one or more ponds, with depth, water productivity and use of watershed most important. Ponds with maximum depths of 15 feet or more, low productivity (as indicated by absence of heavy algae growths), and grass watersheds generally did not winterkill. Ponds as shallow as 8 feet in maximum depth did not winterkill when the water was (1) exceptionally clean (usually due to no cultivation on the watershed and fencing of livestock from all but a small area), or (2) the pond was situated in such a way as to permit winds to blow all snow from the surface, or (3) springs in the pond bottom were sufficiently strong to keep ice from forming over the entire pond.

Examples of major chemical and physical parameters for "typical" shallow (Douglas County) and deep (Grant County) ponds in eastern South Dakota.

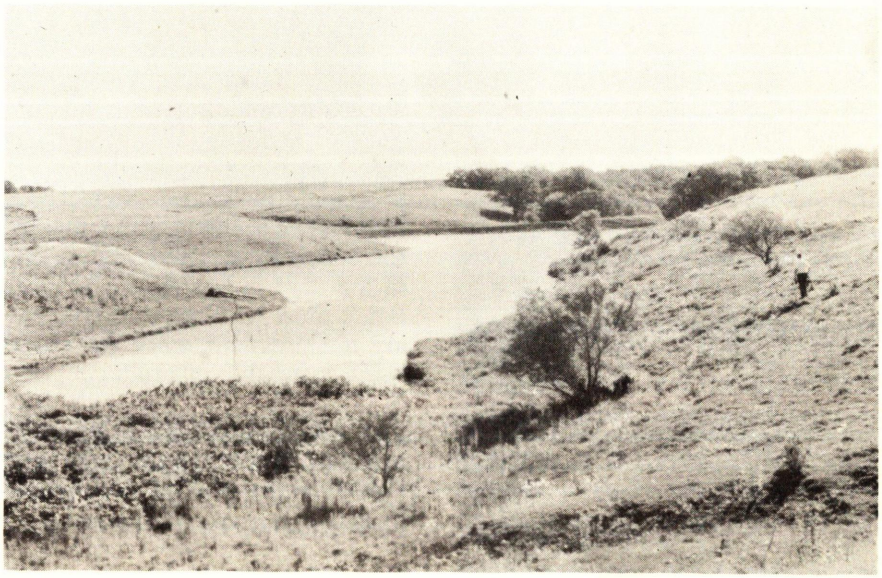
Parameter	Deep Pond	Shallow Pond
Depth	20 feet	10 feet
Size	4 acres	1.2 acres
Size of watershed	100 acres	300+ acres
Specific conductance	500	410
Hardness	250	190
Alkalinity	150	115
Sodium	12	11
Potassium	21	15
Chloride	12	5.5
Sulfate	135	----

The chemical differences between these two ponds are unimportant in terms of winterkill. The deeper pond is actually in a little worse shape but is not considered polluted.

This is winterkill.

Example of a "bad" lake.

Example of a "good" lake.



Progress in blunting $2½ million annual loss . . .

Abortion in Cattle

By
Clyde A. Kirkbride, D.V.M., assistant professor, Department of Veterinary Science, South Dakota State University

SOUTH DAKOTA has about 2 million brood cows on its farms and ranches. Research in neighboring states indicates that approximately 1% of these cows can be expected to abort or produce a stillborn calf. This means that in South Dakota some 20,000 calves will be aborted or stillborn this year.

A recent survey shows that it costs between $100.00 and $120.00 to carry a beef cow through one year. When a cow fails to produce a calf that is able to live and grow, the expense of maintaining her through one year becomes a complete loss. On this basis the loss of 20,000 calves through abortion and stillbirth costs South Dakota cattlemen a net annual loss of nearly $2½ million.

Two years ago a project was started by the Animal Disease Research and Diagnostic Laboratory with three specific purposes:

1. To determine the most common causes of abortion and stillbirth among cattle in South Dakota.
2. To develop better methods of diagnosis of these diseases.
3. To establish and publicize methods for controlling these causes of abortion and stillbirth.

798 Cases Investigated

During the first 2 years of the study, 798 cases of abortion or stillbirth in cattle have been investigated by the laboratory. The number and type of specimens available to the submitting veterinarian differs in each case. Thus, in some cases only the placenta from the cow known to have aborted may be presented to the laboratory while in other cases the aborted fetus along with the placenta, blood samples from the aborting dam and even water and feed samples may be available. According to the number and type of specimens submitted, up to 30 individual laboratory examinations may be carried out on a single case of abortion or stillbirth.

The possible causes of abortion or stillbirth vary greatly. They include such factors as heredity, injury, toxins or poisons from plants or chemicals, hormone imbalances, nutrition, and a wide variety of infectious causes. Many of these individual factors are poorly understood and most of them leave no known recognizable signs in the aborted fetus or placenta. Diagnostic procedures for many of the well recognized causes of abortion and stillbirth are poorly established. Because of these difficulties, the cause of the abortion or stillbirth can be definitely established in only about 25% of the cases.

IBR Main Cause of Abortion

In the study thus far, the virus infection, Infectious Bovine Rhinotracheitis (IBR), is the most commonly diagnosed cause of abortion in cattle in South Dakota. Figures indicate that in South Dakota about one out of every ten bovine abortions — some 2,000 each year — are due to IBR infection. This annual loss by South Dakota cattlemen of nearly a quarter of a million dollars could be completely eliminated by proper control measures.

Research results indicate that a properly immunized cow will be protected from abortion due to IBR infection. However, if calves are vaccinated before they have lost the temporary immunity they acquire by drinking colostrum from an immune dam, vaccination may not produce the desired results. This temporary immunity may last until the calf is 7-8 months of age. It is therefore recommended that all replacement heifers be vaccinated for IBR between the age of 1 year and the time they are bred. Mature cows in the herd may also be vaccinated but it must be done while the cows are not pregnant, since the vaccine itself is capable of producing abortion also. There are good indications that once animals are properly immunized, most remain resistant to IBR infection for the rest of their lives.

New Diagnostic Procedures Developed

Laboratory diagnosis of IBR abortion has been based upon the finding of specific microscopic lesions in the tissues of the aborted fetus. The virus can be isolated from the tissues of about one out of every three fetuses which have the lesions. When the placenta is available for culture the proportion of virus recoveries increases to about 50% of the cases with lesions.

Workers at the Animal Disease Research and Diagnostic Laboratory have been successful in applying immunofluorescent techniques to the diagnosis of IBR abortion. In the procedure which they developed, samples of fetal tissues are sharp frozen with liquid CO_2 and cut into 6-8 micron sections with a cryostat. These sections are mounted on slides and stained with IBR antiserum which has been conjugated with fluorescein isothiocyanate. When the stained tissues are examined microscopically with ultraviolet illumination the positive tissues have a characteristic fluorescence.

This technique has been applied to more than 100 field cases and thus far has been proven to be highly reliable. Inactivated as well as live viruses can be demonstrated in this manner. Since infectious agents other than the IBR virus occasionally produce lesions in the fetus similar to those of IBR, the immunofluorescent technique should prove to be more accurate than the microscopic examination of tissues. Another advantage of the new method is that the results can be available within 2 hours after the fetus is necropsied, whereas the older techniques require 3 to 4 days.

Vibriosis Also Costly

The second most common cause of abortion found in the SDSU study is vibriosis. This venereal disease caused by the bacterium *Vibrio fetus* var. *venerealis,* is apparently responsible for more than 500 bovine abortions in South Dakota each year. Abortion is only a very small part of the loss caused by this infection. Infertility and repeat breeding

of infected cows is far more important then the 5% to 10% maximum abortion rate. All indications are that this infection is widespread in the breeding herds of South Dakota, Nebraska, Colorado, Wyoming, and Montana.

Since vibriosis is a true venereal disease, spread almost entirely through sexual contact, the disease may be controlled through the use of artificial insemination with properly treated semen. However, this procedure is not always practical under range conditions. Cows will generally rid themselves of the infection with from 3 to 6 months of sexual rest. However, an infected bull over 3 years of age may remain infected for the remainder of his life. It is extremely difficult to maintain a herd free of the disease when surrounding herds are infected. Vaccination against the disease has proven to be fairly effective in reducing the losses due to infertility and abortion, however, it apparently does not prevent infection. Various programs are available for immunizing cattle against vibriosis, but most of them require that every brood cow be vaccinated each year. Vaccination of bulls has not been effective.

Both mycotic placentitis and *Corynebacterium pyogenes* infection have been shown to be of equal importance with vibriosis as causes of bovine abortion in South Dakota.

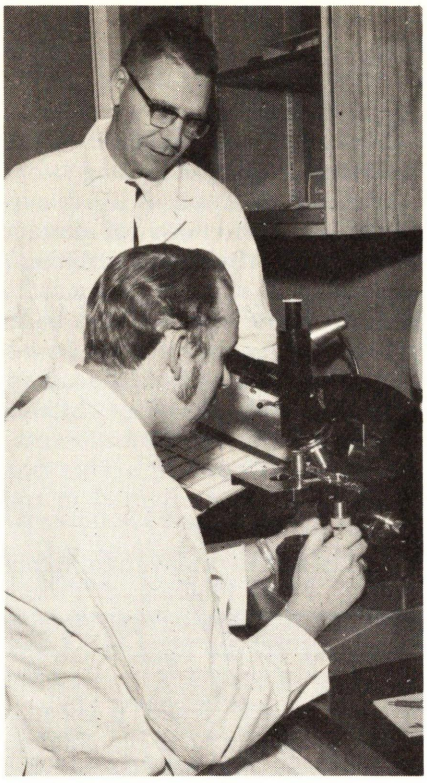
Fungi In Feed Also Blamed

Mycotic placentitis, or fungus abortion, occurs when one of the fungi commonly found in feeds invades the blood stream of the pregnant cow, usually through small ulcers in the rumen, and is carried to the uterus. There, under circumstances which are incompletely understood, it attacks the placenta and interferes with the transmission of nutrients from the dam to the fetus. The fungi most often isolated from aborted fetuses in South Dakota are *Aspergillus fumagatus* and *A. terreus*. Abortions due to fungi are usually sporadic and seldom is any large percentage of calves lost from one herd.

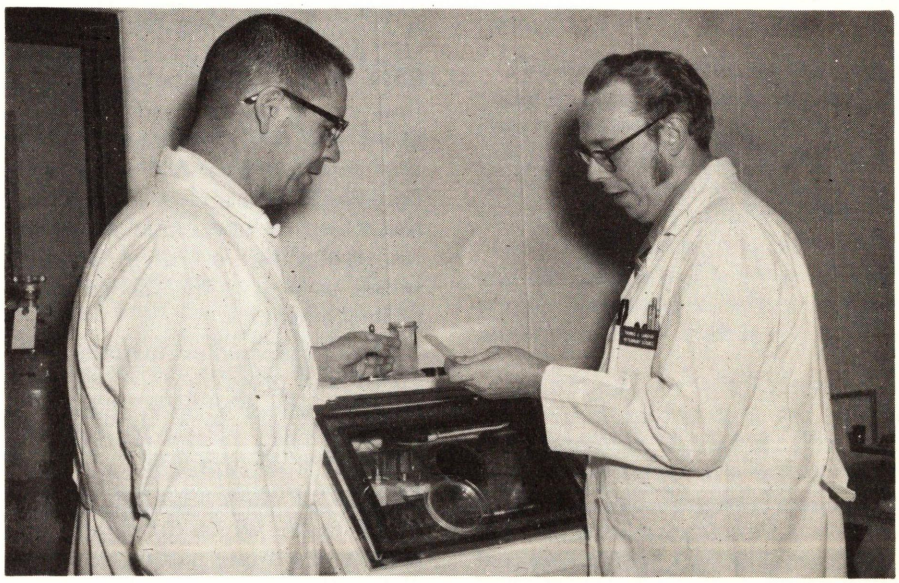
At present, no recommendations can be given for controlling this disease. No vaccines are available and the conditions under which the disease occurs are not known. Preparations are underway at the Animal Disease Research and Diagnostic Laboratory to investigate some aspects of this problem.

C. pyogenes is a bacterium commonly associated with pneumonia, abscesses and joint infections in cattle, swine, and sheep. It has been known to cause abortions in cattle and sheep but the frequency of its occurrence as a bovine abortifacient in this area is somewhat surprising.

Little is known about the epizootiology or pathogenesis of *C. pyogenes* in cattle abortions. Vaccines containing this organism have been available for years, but their efficacy in preventing abortion is unknown. Personnel in the South Dakota Animal Disease Research and Diagnostic Laboratory hope to undertake projects in the near future which will aid in the understanding and control of this disease.□



Tom Langpap, technologist, views a tissue section with a special ultraviolet illuminated microscope. Looking on is Clyde A. Kirkbride, D.V.M., assistant professor, Department of Veterinary Science. Langpap is a graduate bacteriologist from SDSU.



Prior to viewing in the microscope, a tissue section is removed from a cryostat, an instrument that cuts the quick frozen original tissue into very thin slices.

A photomicrograph of a section of a fetal kidney shows fluorescence (light area) denoting presence of the IBR virus in the tissue. Because of the fluorescent stain used, in actual viewing the light area appears bright green.

Families of Children in the Head Start Program

By
Christopher L. Smith and **Marvin P. Riley**
Mr. Smith, former graduate assistant in the Rural Sociology Department, is now an instructor at Concordia College, Moorhead, Minn. Dr. Riley is professor of rural sociology, South Dakota State University.

POVERTY is not new to our country or to our time.

However, poverty seems out of place in a nation which enjoys one of the highest levels of living ever recorded. The effects of chronic poverty are often incapacitating—especially for children. Frequently, children from impoverished backgrounds begin their formal education with extremely limited reading, speaking, and reasoning abilities, and their experiences with life may not include any activities other than those which have occurred in and around their homes.

An attempt to deal with this problem is a major function of "Project Head Start," created and largely sponsored by the Federal government. Head Start is a comprehensive program designed to enhance the development of young children from low-income families by providing extensive medical, nutritional, educational, social and psychological services at that crucial time before they start their formal schooling.

When considering the influences that parents and home environment have on the preschooler's intellectual, emotional, and social development, it quickly becomes apparent that a comprehensive program to help children from low-income families depends upon knowledge and understanding of their families' needs, as well as the specific needs of the children.

Most published evaluations of the Head Start program since 1965 have focused primarily upon changes or improvements to the participating children. Few studies even mention families of these children, and of those studies which do, reference is usually of a minor nature.

An attempt to gain insights and more information about the characteristics of these low-income families who had children in the Head Start program was made last year by the Rural Sociology Department and the Agricultural Experiment Station. This was included as one phase of a larger study dealing with the characteristics of low-income families in Brookings, Kingsbury, and Moody counties.

Seek Family Data

The Head Start study was seeking to gain information about two major questions: "What are the characteristics of a sample of Head Start families?" and "Are these families similar to other poverty-type families." (For more detailed information see "Characteristics of Low-Income Families in the Head Start Program in Three Eastern South Dakota Counties," unpublished Masters Thesis, South Dakota State University.)

Forty-four families, out of 120 families interviewed for the larger study, were included in the sample of Head Start families, for which extensive information was gathered by means of an interview schedule.

It was found that the 44 Head Start families tended to be considerably larger than average. Eight family members was the average size and 20 of the 44 families had nine or more family members. The families would also be able to have still more children as 39 of the 44 mothers were below the age of 45 years—the commonly cited upper age limit for fertility in the United States. The median age for the sample mothers was 33 years with the youngest being 23 and the oldest 51. However, fathers were somewhat older than the mothers; average age for the fathers was 40 years and ranged from 24 to 58.

Most families were headed by a male; only five families reported a female household head. Thirty-one lived in towns and 13 in the country. All fathers said that they were employed at the time of the interview, and of these, 34 said they were employed full-time. Four fathers said they were employed part-time, and one father reported holding both a full-time and a part-time job. However, one-fifth of the fathers said they had been unemployed at some time within the last 12 months. All but two had been employed for at least 7 of the preceding 12 months.

Annual Family Income Low

Although most of the fathers were employed full-time and some mothers were employed part-time, the annual family income was quite low. Only one family reported an annual income exceeding $5,000. All

others reported incomes under that figure. In fact, two families said their annual income was below $1,000. Median annual family income was $3,000, or an average of $375 per person.

With respect to education, only five of the fathers and four of the mothers had any formal education beyond high school. Two-fifths of the fathers and two-thirds of the mothers had completed from 9 to 12 years of school. However, half of the fathers, as compared to one-fourth of the mothers, had completed 8 years or less of formal education. The average number of years of schooling for the mothers was 11 and for the fathers it was 8½ years. In spite of, or because of, the educational attainment of the parents it was determined that they tended to be favorable toward education in general. Slightly more than half of them expressed strongly favorable attitudes toward education.

"Traditional" in Beliefs

One theory on the existence of poverty contends that poor persons are members of a culture or subculture of poverty, in which certain characteristics develop among the members in response to the common conditions of poverty. Some of these characteristics include large families frequently headed by a female with a low family income, high unemployment rates, and low levels of education — all of which have been discussed above. Certain attitudes and values are also frequently cited as being associated with poverty. Poor people are seen as holding more "traditional" beliefs about family relations, wherein the male is considered to be the dominant figure in the family. Traditional family beliefs stand in contrast to more "democratic" beliefs where the male and female tend to be more equal in family affairs. It was found in this study that 39 of the 44 families indicated some traditional beliefs about family relations, and almost two-fifths of them held "strongly traditional" beliefs.

Another social - psychological characteristic frequently attributed to persons in poverty is the phenomenon of anomie. Anomie is usually interpreted as including attitudes of fatalism or resignation generated by a realization that one has little control over his own life. Although there was found to be a definite indication of anomie among the responding parents in the study, the indications were not strong. Only four of the 40 persons who responded to all of the questions were classified as possessing strong feelings of anomie, while one-fourth indicated mild anomie. On the other hand almost two-thirds displayed from weak to little or no feelings of anomie.

Oriented to Future

Due to the uncertainly and insecurity of the poverty situation, the poor are often described as possessing a time perspective which is oriented to the present—for the immediate gratification of needs and desires. The Head Start parents in the study tended to be more oriented to the future rather than to the present. No indication of a strong present orientation was found and about one-tenth showed a mild future orientation. Instead, about two-fifths displayed a mild orientation to the future while about half indicated a strong future time orientation.

Parental attitudes and knowledge about the Head Start program as well as frequency of participation of the parents in Head Start activities were also studied. Parents were asked about their views on the effects of Head Start on the participating child, the effects of the child's participation on the rest of the family, the administration of the program, the facilities of the program, and whether or not they felt there was some stigma attached to the family because their child was in the Head Start program.

While the parents generally responded quite favorably with respect to the above questions, they were in almost complete agreement on their responses to the question about the effect of their child's participation on the rest of the family. Here, 35 of the 44 respondents were strongly favorable about the effects on relations within the family from the child's participation in the program. Half the respondents were strongly favorable with respect to the effects of Head Start on the participating child. The same was found with regard to the administration and the facilities of the program as well. Twenty of the 38 responding to this question felt little or no stigma was attached to their families due to their association with the Head Start program. Over two-fifths indicated that they felt weak stigma, and only two felt they were stigmatized mildly. No respondents indicated feelings of a strong stigma on the family from associating with Head Start.

Know About Head Start

Questions which would indicate the extent of their knowledge of the Head Start program were also asked of the parents. Here, 36 were found to possess a high degree of knowledge. In addition, it was found that better than one-fourth of the parents said they participated in Head Start activities "often," while at the same time almost two-fifths said they participated "sometimes" and one-third indicated their participation rate was "seldom" or "none."

The study has facilitated the outlining of areas which are in need of closer, more detailed investigation. Future studies of Head Start families, for example, may choose to examine what, if any, relationships exist between family characteristics and the intellectual, emotional, and social deficiencies often found among poverty children.

In addition, the study has provided needed information on Head Start families. The family size was large while the family income was very low, due, in part, to the low educational attainment of the chief breadwinners of the families. These factors make efforts extremely difficult for these people to help themselves out of the situation of poverty. The fact that the parental attitudes toward the Head Start program were very favorable suggests that the program may possibly serve as a viable means for these people to help themselves, as well as their children, in their attempts to break out of the cycle of poverty.□

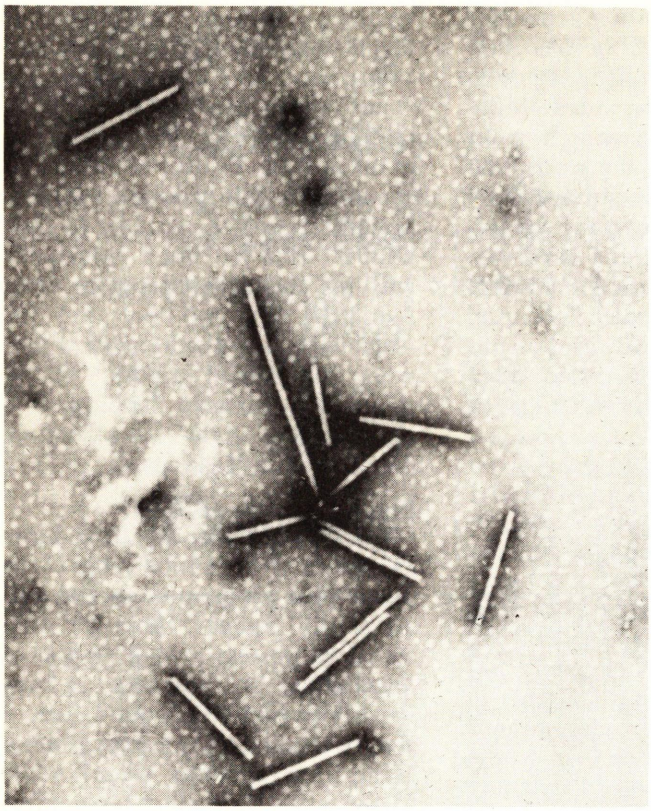


Figure 1—This is tobacco mosaic virus, a common pest of tomato plants, which appears here as small bits of straw. These were recovered from tomato plants sent to plant pathologists at SDSU. This virus is so uniform in size that it is used as a reference for determining the size of other viruses. Its dimensions are 18x300 nanometers—small indeed when you consider that it takes 25,400,000 nanometers to make an inch.

Figure 2—These particles of wheat streak mosaic virus are like those recovered from diseased wheat and corn in South Dakota. This parasite is responsible for an annual loss of about $1 million to South Dakota winter wheat growers.

Unseen Parasites That Damage Your Crops

South Dakota farmers usually have to take the scientist's word for it when plant diseases are described as being caused by viruses, the smallest parasites known to cause disease in living things.

The main reason is that viruses are so small that they cannot be seen except with the most powerful of microscopes. One of the types of microscopes used in this work is at the federal Northern Grain Insects Research Laboratory north of Brookings. The use of this electron microscope is sometimes "borrowed" by Agricultural Experiment Station personnel.

Wayne S. Gardner, associate professor in SDSU's Plant Science Department, finds the electron microscope a valuable aid in his research with plant diseases. Dr. Gardner says the viruses may be quickly identified from field samples and are revealed in a rapid diagnostic method called "quick-dip" in negative stains.

The accompanying photographs, obtained through use of the electron microscope, show some of the viruses which may be causing losses in your crops. (The virus particles are magnified about 50,000 times in the photographs).□

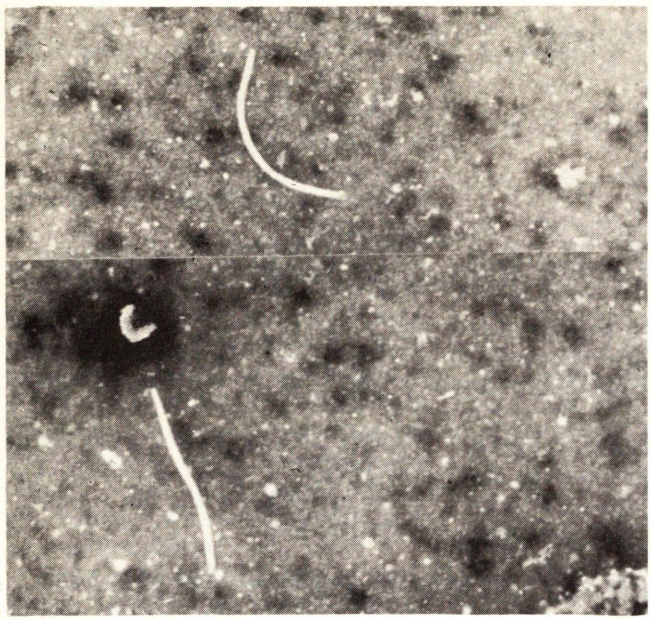


Figure 3—Routine sampling from soybean plants revealed these virus particles.

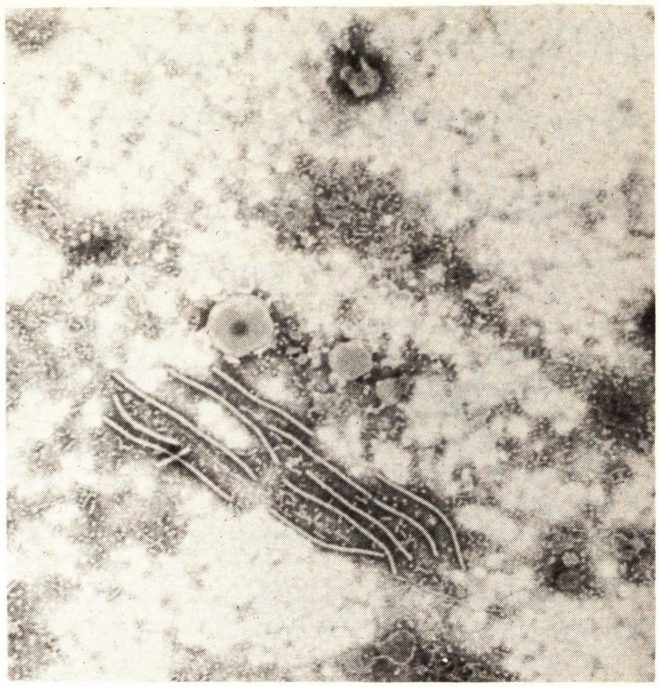


Figure 4—Alfalfa is known to be attacked by several viruses. These were recovered from plants growing in experimental plots at Brookings.

Figure 5—These particles cause the disease called barley stripe mosaic. The spread of this disease is usually by infected seed.

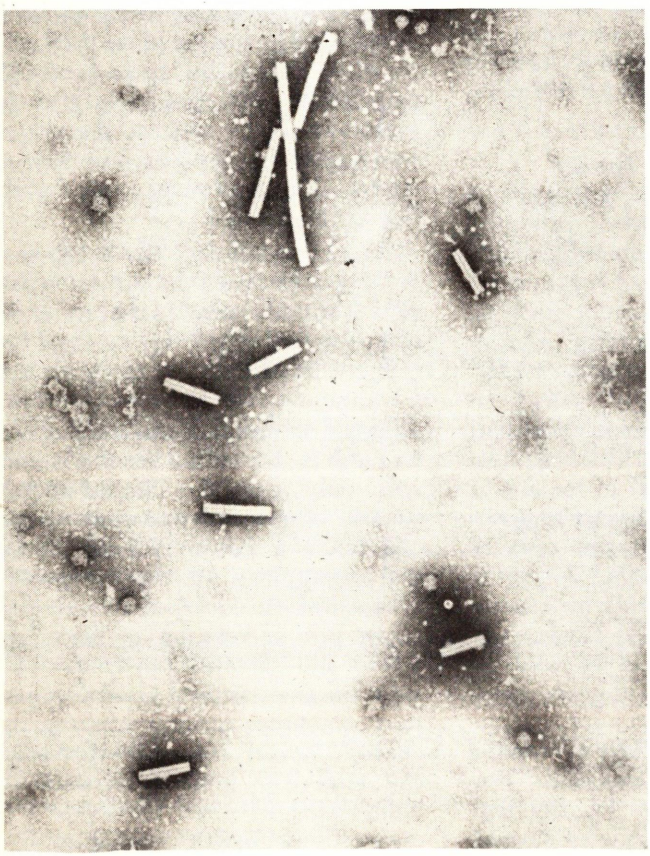
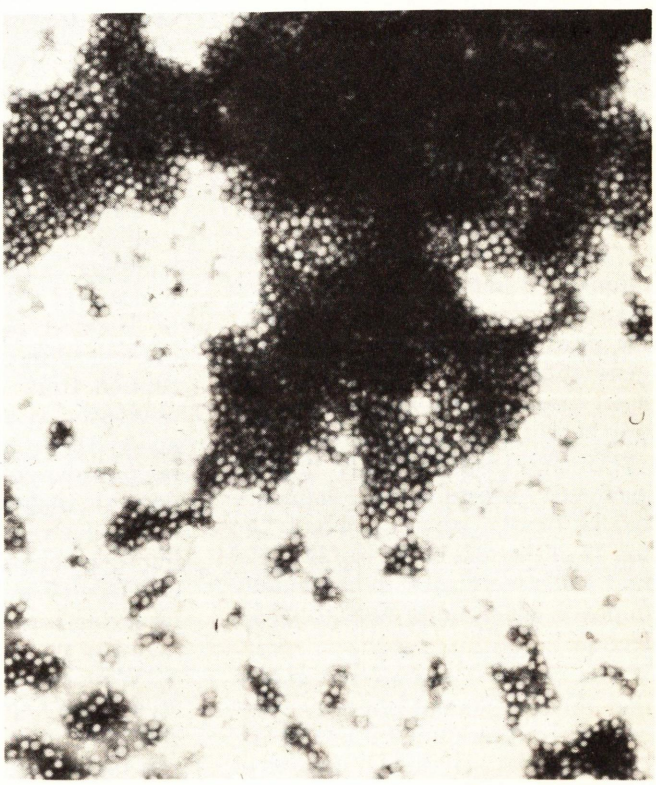


Figure 6—Brome mosaic virus is one that is shaped like tiny round balls. These particles were recovered from smooth bromegrass growing in experimental plots at Brookings. This virus has also been found in South Dakota corn fields.



Bull Selection Still the Rancher's Most Important Decision

DENVER, COLO. — The successful livestock producer must keep track of at least two bull selection programs—his own and that of the herd from which he buys his bulls, a South Dakota State University beef breeding researcher told the fifth conference on artificial insemination of beef cattle sponsored by the National Association of Animal Breeders here in January.

"It's a matter of each generation building upon previous generations if continuous genetic improvement is to be expected in beef cattle," according to C. A. Dinkel, professor of animal science with the South Dakota Agricultural Experiment Station.

"We are talking about genes for good growth which, obviously, cannot get into the commercial herd unless they are first brought into the seedstock herd that is the source of bulls for the commercial herd," Dr. Dinkel explained. He emphasized that 90% of the improvement to be made in a herd over the next 15 years will come through bull selection. This means that the successful producer must go back into the selection program of the herd from which he buys his bulls.

Artificial Insemination Role

"A major role of artificial insemination is to increase even more the selection pressure on the bull side," Dr. Dinkel added. "If we can build generation upon generation, artificial insemination will increase the rate at which we can improve.

"An approximate upper limit of artificial insemination influence would be the situation where the top 1% of the sons of the top 1% of the best bulls were used to continually improve generations through AI selection."

The South Dakotan recognized that there is limited opportunity at present for this kind of selection because of relatively small numbers of sons returning to AI service. "It is one thing to view the possibilities theoretically but quite another to go out to the ranch and actually accomplish this kind of improvement," he added. "Finding the top 1% of the bulls in any one breed is a monumental task although finding the best 1% of their sons would be considerably easier once the sires were located."

Dr. Dinkel advised livestock producers to find the "breeder or AI stud that has the same definition of 'best' as they do and preferably the one who has bred toward that goal for the longest time." He suggested that national sire evaluation programs for beef similar to those now in use for dairy should help bring together the theoretical and practical aspects. Acknowledging difficult and complicated factors would be faced initially, the SDSU animal scientist indicated that a national sire evaluation procedure would not necessarily mean that every herd in every breed would have the same goal.

Retain Management Factors

"All of the regular management factors that a livestock producer uses for a successful operation must be retained as well as giving consideration to added factors such as handling and processing of the semen and the insemination itself," he pointed out."These cannot be minimized in importance since conception from the artificial service, obviously, is a 'must' if we are to achieve the more rapid rate of genetic improvement that this type of program makes possible."

He illustrated his talk on genetic improvement expected from artificial insemination with an analogy involving bull selection goals and a highway system.

"We can travel different routes at different speeds," he said. "For example, on a fairly lengthy trip you can choose any one of several State-Federal highways and travel at a speed limit of about 60 miles an hour. The analogy in beef breeding is comparing this to natural service where we have the choice among several bulls that could take us toward our selection goal at nearly the same rate.

"If we want to travel faster, we lose some of our options, that is, we don't have as wide a choice of highways—in fact, the Interstate system would be about all that is available for faster travel, say at a 90 m.p.h. limit. The faster travel permitted on the Interstate would be comparable to artificial insemination in rate of improvement."

Sees No Genetic Variation Loss

Additionally, the SDSU animal scientist analogized: Not all of the towns we might want to visit or live in are situated on the Interstate highway and not all selection goals would be available to one participating in a national sire evaluation program. "However, in addition to faster rate of improvement, these programs would offer a more constant selection goal. Beef programs should have an advantage over the dairy programs presently in use in that many important traits of beef cattle can be measured on the bull. I see no reason for concern about possibilities of exhausting genetic variation—again, look at the situation in dairy, where the number of traits under selection is probably fewer than in beef.

"Consider again the highway analogy: the Interstate system is designed to pass near a large number of people although they may not be living directly on it—the greatest advantage for the greatest number. Also, all drivers will not use the Interstate to the same extent, some will only use the State-Federal routes, others only country roads and lanes—a few may even travel the wrong way on the Interstate! These last three types of drivers, when put in relation to selection goals and artifical insemination, maintain the source of genetic variation sometimes needed when goals change. As an example: currently this reserve of genetic variation is being used in some breeds to increase their growth capability."□

Comparing Hay Storage Methods

By
Perry Fales, Day County Extension Agent,
Webster, S. D.

LABOR IS a big item in the farming business whether it comes during small grain harvest or hay harvest. The amount of labor required to do many jobs has been drastically reduced. Putting up hay has been a laborious job but labor saving devices such as stack frames, stack movers, mechanical bale pickers, and bale stackers are reducing the labor requirements.

These new labor saving devices have resulted in most of the hay being stored outside and exposed to weather during summer and winter months. The amount of nutrients conserved until the hay is fed is primarily the result of the storage method chosen.

South Dakota is one of the leading hay producing states. This study was conducted to determine the amount of nutrients lost during storage. Comparisons were made between baled and loose hay, and between hay that was exposed to the weather in outside stacks and stacks that were protected with a plastic sheet. Only first cutting alfalfa hay was used.

Ten farmers in northeastern South Dakota cooperated in the study. Hay was harvested in the manner the 10 cooperators customarily used. Hay was stored outside in at least two stacks. One stack was covered with a black polyethylene plastic sheet and the other was left exposed to the weather.

Five farmers baled their hay and the other five stacked their hay loose.

The hay was sampled as it was placed in the stacks. This sample was the basis for comparing the samples taken after the storage period. Following 4 months of storage, the covered and uncovered stacks on each farm were resampled and comparisons made.

Nutrient Loss

Samples were analyzed for proximate analysis, digestible dry matter

(Continued on page 32)

Perry Fales, author of this article, has been an Extension agent—first as assistant county agent and later as county agent—in Day County since April 1959. He graduated from SDSU in 1959 with a bachelor's degree in agricultural education.

He later returned to SDSU and obtained his master's degree in 1970 in dairy science. Research he conducted in connection with his master's degree work involved methods of storing hay. In this article he discusses some of the findings of his study.

Fales was born and reared on a small farm near Canby, in west-central Minnesota.

Table 1. Chemical composition (in percent) of first cutting alfalfa hay as affected by cover and method of harvesting on 10 northeastern South Dakota farms in 1968 and 1969.

Nutrient	Baled			Loose		
	Before	After		Before	After	
		Covered	Uncovered		Covered	Uncovered
Crude protein	18.23	19.73	19.23	16.91	17.42	17.22
Crude fiber	26.60	23.13	27.01	26.27	30.84	32.38
Ether extract	1.80	1.68	1.68	1.63	1.83	1.80
Ash	8.87	9.04	9.91	6.80	8.98	9.45
N-free extract	49.30	46.42	42.18	46.92	41.58	39.15
Digestible dry matter	64.86	63.83	58.46	66.24	61.34	56.00
Carotene mg/lb.	11.80	4.68	3.48	14.84	3.75	2.63

"Before"=a 4-month storage period or as stacked.
"After"=a 4-month storage period.
"Covered"=with a polyethylene plastic sheet.
"Uncovered"=or left exposed to the weather during the 4-month storage period.

Table 2. Percent change in chemical composition of first cutting alfalfa hay as affected by method of harvest and storage method.

Nutrient	Baled		Loose	
	Covered	Uncovered	Covered	Uncovered
Crude protein	+8.23	+5.23	+3.02	+1.83
Crude fiber	–13.05	+1.54	+17.40	+23.26
Ether extract	–6.67	–6.67	+12.27	+10.43
Ash	+1.92	+11.72	+32.06	+38.97
N-free extract	–5.84	–14.41	–11.38	–16.56
Digestible dry matter	–1.59	–9.87	–7.40	–15.46
Carotene	–60.34	–70.51	–74.73	–82.28

"Covered"=with a polyethlyene plastic sheet.
"Uncovered"=or left exposed to the weather during the 4-month storage period.

HAY STORAGE . . .
from page 31

(DDM) and carotene. Values obtained are shown in Table 1 comparing the baled as stacked (before) with the covered and uncovered after storage, and loose as stacked (before) with the covered and uncovered after storage. No significant differences were noted when baled covered hay was compared with the loose covered hay or when the baled uncovered hay was compared with the loose uncovered hay at the end of the storage period.

The cover was effective and more nutrients were conserved in the covered hay than in the uncovered hay. The covered hay had significantly more digestible dry matter (DDM), nitrogen free extract (NFE) and carotene. The uncovered hay was significantly higher in crude fiber and ash. These two nutrients tend to make the hay less digestible to animals.

Storage

In this study black polyethylene plastic sheet (4-mil) was used to cover half the stacks. A nylon bird netting was also used to help keep the plastic sheet from billowing in the wind. Both the plastic sheet and the netting where weighted to keep them on the stack. There were problems in keeping the plastic covers on the stacks because of the wind. The nylon netting weathered quite badly during the summer and was easily ripped after about 2 months of exposure.

A pole type hay shed would be a more practical cover because of the problem of keeping the plastic on the stacks. A 25x40-foot pole hay shed 12 feet high would cost about $1,000 and would hold 60 tons of baled hay. The annual storage cost per ton would be $2.03 as shown in Table 4. The annual storage cost per ton using the plastic sheet and netting was $1.10 for baled hay and $2.20 for loose hay. Three-fourths of the cost of the covering materials was for the nylon bird netting.

Savings

The amount of crude protein did not vary significantly when covered hay was compared to uncovered hay. Earlier work by researchers indicate the same thing, however, they found that molding or browning of alfalfa hay caused the digestion coefficient of crude protein to be as much as 23.9% lower than good bright hay. Cattle will readily eat brown alfalfa even though it may not have as many nutrients as the brighter green hay.

The values of covered hay as affected by crude protein and estimated digestible protein saved is calculated as follows:

Covered

2,000
X 18.58% crude protein*
371.6 pounds C.P./ton

*Average of baled and loose covered hay.

371.6
X76.9% digestible protein
285.8 pounds D.P./ton

Uncovered

2,000
X 18.23% crude protein†
364.6 pounds C.P./ton

†Average of baled and loose uncovered hay.

364.6
X53.0% digestible protein
193.2 pounds D.P./ton

If the covered hay is valued at $20.00 per ton, each pound of digestible protein is worth 7 cents.

285.8
X .07
$20.00 value per ton

193.2
X .07
$13.52 value per ton

This amounts to a saving of $6.48 per ton in digestible protein by covering the stack and protecting it from the weather. If we compare the digestible dry matter (DDM) by the same method the savings would be $1.68 per ton.

Table 3 shows the expected savings from covering hay for the two nutrients and three methods of storage.

Table 3. The expected annual storage cost, value of two nutrients saved by covering, and net savings per ton per year of first cutting alfalfa hay harvested and stored in northeastern South Dakota in 1968 and 1969.

Method	Cover	Annual Cost/ton	Savings/ton† DDM	Savings/ton† CP	Net savings/ton‡ DDM	Net savings/ton‡ CP
Loose	Plastic/netting*	$2.20	$1.68	$6.48	$–.52	$4.28
Baled	Plastic/netting*	1.10	1.68	6.48	.58	5.38
Baled	Hay shed§	2.03	1.68	6.48	–.35	4.45

*Four-mil black polyethylene plastic sheet covered with a weighted nylon netting.
†Estimated from the value of nutrients saved.
‡Computed from storage costs and value of nutrients saved.
§Computed from the annual ownership costs of a 25x40x12-foot pole hay shed used to store 60 tons of hay annually with a new cost of $1,000.

Table 4. The estimated annual storage cost per ton in a 25x40x12-foot pole type hay shed used to store 60 tons of alfalfa hay annually.

Building Cost	$1,000	
Depreciation	(5% x new cost—$100 salvage)	$ 45.00
Interest	(8% x new cost + salvage) / 2	44.00
Repairs	(1% x new cost)	10.00
Taxes	(2% x new cost)	20.00
Insurance	(0.25% x new cost)	2.50
	Total annual cost	$121.50
	Total annual cost per ton	$ 2.03

SUMMARY

The plastic cover was effective in conserving more nutrients in the hay. It more than paid for itself in the amount of digestible protein conserved when used on baled and loose hay. The cover paid for itself in the amount of DDM conserved in baled hay but not in loose hay. A pole type hay shed could be paid for on the basis of the amount of digestible protein conserved but not on the basis of the DDM conserved.

Because of the problems in holding down the plastic cover on the stacks, a hay shed would appear to be the best way to protect hay from weather unless the added labor is available to put hay in the mow of a general purpose barn.□

Wild Buckwheat Control

By
J. E. Stritzke, former assistant professor of agronomy, and **C. E. Stymiest,** former instructor of agronomy.

WILD BUCKWHEAT *(Polygonum convolvus L.)*

Drawing from Bulletin 498, "Weeds of Wyoming," courtesy of Agricultural Experiment Station, University of Wyoming.

WILD buckwheat *(Polygonum convolvulus* L.) is a major weed problem in most spring small grain areas of South Dakota. It is an annual weed that germinates in April and competes with the crops for nutrients and moisture. In addition to competition, vines of the plant present a major harvesting problem.

Several factors are responsible for the build-up of buckwheat infestations resulting in the weed problem we have today. Seeds of wild buckwheat are similar in size to the small grains and are often planted with seed grains. Also, MCPA and 2,4-D, which have been extensively used on these crops, only suppress the growth of wild buckwheat. Another factor which has recently added to the problem is the increased use of fertilizer. Wild buckwheat becomes much more competitive under high levels of fertility. The severe wild buckwheat problems in fields following a year of fallow is attributed to the high fertility level of fallowed fields.

Four years of studies were conducted on small grains infested with wild buckwheat to answer the following questions:

1. How can wild buckwheat be controlled?
2. What kind of grain yield can be expected from the various treatments?

Experimental Information

The studies on wild buckwheat control in small grains were conducted on the Northeast Research Farm units at Watertown in 1966 and at Garden City in 1967, 1968, and 1969. Grain fields in these areas have been treated regularly with 2,4-D. A heavy infestation of wild buckwheat seed in the soil resulted in a weed stand at spraying time of 7 to 22 plants per square foot. Only light infestations (less than 1 plant per square yard) were noted of other broadleaf weeds such as ragweed, sunflower, lambsquarter, kochia, mustard, and Russian thistle.

The spraying was done when the small grains were in the 5- to 6-leaf stage. This was usually around the 1st of June. At this time the wild buckwheat, kochia, and pigweed would be 2 to 3 inches tall and lambsquarter and sunflower 4 inches tall. All plots were sprayed with a tractor sprayer applying 20 gallons of spray solution per acre. The areas were fertilized according to fertility recommendations from soil tests.

Results

Data in Table 1 indicate that wild buckwheat can be controlled. All herbicides listed gave good initial control and a significant reduction of wild buckwheat seed in the harvested grain. The various formulations of 2,4-D and the 1 oz/A of dicamba plus 4 oz/A of MCPA treatments were not as effective as the other treatments.

The resulting yields from some of the herbicide treatments are listed

(Continued on page 34)

WILD BUCKWHEAT . . . from page 33

in Table 2. Four-year averages were not available for all of the herbicides listed in Table 1. The top yields were obtained on plots treated with bromoxynil plus MCPA. Good grain yields were also obtained on plots not sprayed and there were no significant differences among the yields of barley and wheat from the various treatments. Also, none of the yields from sprayed oat plots significantly outyielded the unsprayed plots but 2,4-D significantly reduced the oat yield.

Yields of barley and wheat from plots treated with diuron were reduced both years it was evaluated. The control of other broadleaf weeds was also inadequate with diuron.

Picloram in combination with MCPA and 2,4-D gave fair control of other broadleaf weeds and good yields of wheat and barley were obtained. The yield of oats was often reduced whenever the 6 oz/A rate of 2,4-D was used in the mixture.

The best control of other broadleaf weeds was obtained with bromoxynil plus MCPA or 2,4-D. Dicamba in combination with MCPA or 2,4-D gave fair to good control of the other broadleaf weeds. Bromoxynil alone also gives excellent control of other broadleaf weeds when applied to small weeds. However, wild mustard plants over 6 inches tall are not controlled with bromoxynil.

Table 1. Wild buckwheat control with various herbicides and herbicide mixtures.

Herbicide	Rate oz/A	Wild Buckwheat Control % Estimate*	Wild Buckwheat Control Number of Weed§ Seeds/250 gms, Grain
None		0	360
2,4-D Amine	12	48†	44
2,4-D Butyl ester	8	41†	51
2,4-D LV ester	8	53†	61
Bromoxynil	4	90†	10
Bromoxynil	6	95†	8
Bromoxynil + MCPA	4+4	90‡	7
Dicamba + MCPA	1+4	64‡	45
Dicamba + MCPA	2+4	69‡	13
Dicamba + 2,4-D	1+4	66‡	13
Dicamba + 2,4-D	2+4	78‡	8
Picloram + 2,4-D	¼+4	87‖	5‖
Picloram + 2,4-D	⅜+6	90‖	6‖
Picloram + MCPA	⅜+6	84‖	6‖
Diuron	.8 lb	96§	5

*Estimate of control 1 month after spraying.
†3-year average.
‡4-year average.
§2-year average of number of wild buckwheat seeds per 250 grams of grain.
‖Data for only 1 year.

Bromoxynil alone was evaluated at the 2-, 4-, and 6-oz/A rates. Two years of results indicate that 92% of wild buckwheat can be controlled with the 2 oz/A rate. The 4- and 6-oz/A rates gave 97% and 99% control, respectively.

Conclusions

1. Wild buckwheat can be controlled with a number of herbicide treatments.
2. Competition of wild buckwheat under the present farming practices of northeast South Dakota does not drastically reduce small grain yields but primarily presents a harvesting problem.
3. Treating oat fields which have light infestation of weeds with 2,4-D may actually be reducing the yield of oats.
4. Best weed control and crop yields were obtained when a mixture of bromoxynil plus MCPA was used.
5. A 2 oz/A rate of bromoxynil gives satisfactory control of wild buckwheat providing the weeds are treated when less than 2 inches tall and applications are made when temperatures are over 70°F. Complete coverage is also very important with bromoxynil since bromoxynil is a contact herbicide.

SUMMARY

The herbicide treatment which should be applied to small grains to control weeds depends on various factors:

1. The weed problem (kind and amount).
2. The herbicides must be cleared for use on feed crops.
3. The tolerance of the crop to the herbicide (margin of selectivity).
4. The importance of weed-free grain (for seed purposes or feed).
5. Cost of various treatments.

Most of these factors change yearly and the user must analyze each new situation before deciding on a weed control program.□

80,000 Corn Plants Per Acre!

HAVE YOU ever wondered what would happen in South Dakota with extremely high corn plant populations—say 80,000 an acre, which is about five times more than normal?

Research has some of the answers: for instance, last year you would have planted something like 60,000 plants an acre too much, and silage quality would have been on the low side. The research was conducted with varieties of full, short, and very short season corn planted at 20,000, 40,000, and 80,000 population levels in 10-, 20-, and 40-inch rows at the Southeast South Dakota Experiment Farm near Beresford.

"Although we didn't plan it that way, we found some of the things that happen to different plant populations under droughty conditions," says Paul L. Carson, professor in the Plant Science Department at South Dakota State University. "Silage yields show no practical differences in tonnage produced. And this was from any combination of row spacing that differed as much as 30 inches, populations that differed by up to 60,000 plants an acre, and corn varieties with as much as 35 days variation in maturity dates."

Silage quality showed a difference with the best by a considerable margin from the short season (75-day) variety planted at the lowest (20,000) per acre population, according to the Agricultural Experiment Station agronomist. "The difference was that corn in the lower population plots had ears and some grain while the highest populations didn't produce an ear," he added. "Almost needless to say, moisture this year was definitely a limiting factor—we got results that we could normally expect at Highmore, for instance, farther to the northwest."

Carson said the research will be continued, hopefully with more nearly normal moisture conditions in the future. Researchers want to determine at least three things from the experiments: if leaf area of early and full maturity corn is the same will the yield be the same; the potential of high population early corn; and the effects of row spacing and populations on late and very early corn varieties.□

Beef Cattle Research Reviewed at Field Day

BEEF CATTLE research progress and developments at South Dakota State University were featured during the annual Beef Cattle Field Day attended by several hundred producers last October.

Heading the field day program was Earl Mobley, a specialist in environmental control and confinement housing of beef cattle for the Cooperative Extension Service at Iowa State University. He cited research showing that winter climate in northern states can adversely affect feedlot gains but relatively simple structures profoundly modify the impact of severe weather. Weather is only one factor to consider. He listed additional considerations such as pollution control, convenience, greater feed efficiency, faster gains, and need for sharper management.

Others on the program were research personnel from SDSU Agricultural Experiment Station and Cooperative Extension Service.

More research is needed to provide practical methods for what is now done experimentally with hormone injections that lead to multiple births in cattle, reported Travis Rich. He added that when and if induced twinning is a practical reality, the livestock producer must provide excellent management, more facilities and additional labor.

Cattle are potential pollution fighters, noted Leslie D. Kamstra, in reporting experiments in which beef cattle apparently thrived on rations containing various amounts of sawdust, a lumber industry byproduct often piled or burned in the Black Hills area. The research was part of a study of fibrous wastes as potential components in cattle and sheep rations.

Extension Specialist James J. O'Connell urged South Dakota producers to consider backgrounding feeder cattle as a potential profit maker because it offers several market options. He explained that growing out calves offers a market for forage in areas of the state where abundant supplies of hay and silage are produced.

High-moisture corn looks good in many growing and finishing rations for cattle, Lawrence B. Embry said in reporting results of several experiments. This is important to South Dakota cattle feeders because of advantages of harvesting early, the frequent necessity to harvest corn at high moisture content, and the fact that high quality forages should make up an important part of many cattle growing-finishing rations in this area, he added.

J. A. Minyard, Extension livestock specialist, suggested to cow-calf producers a 3-point guide in connection with winter feeding: know nutritive requirements, know nutritive value of common feeds, and feed beef cows according to the "work" they do.

Reporting on research with liquid supplements, Richard M. Luther advised livestock producers to look at it as an additional feeding method which might or might not carry profitable advantages. "Liquid or dry, success depends on how well either supplements other feeds in the ration," he said.

Keeping records can be a money-making proposition for either the purebred cattle breeder or the commercial producer, said Chris Dinkel, reporting results of several research projects. "A cattleman stays in business by successfully combining a sequence of predictions—and it's done with records that give him a look at the past which he can combine with his experience and ability to move along the right path to future profits."□

A Search for Winter Hardiness

THE SOUTH DAKOTA winter wheat producer each year faces the prospect of planting a crop in the fall only to discover in the spring that he has a reduced stand in parts or all of his field.

His problem frequently is winter kill. It may cost South Dakota growers thousands of dollars a year. On the other hand the grower may also be rewarded with a bountiful harvest, because his crop made maximal use of limited rainfall and it has avoided the dangers of head blast due to hot summer winds.

These extreme results often depend on weather conditions during that time of year when we prefer to sit inside by the fire.

The grower can plant wheat varieties with a certain amount of winter hardiness "built" into them by plant breeding efforts, but even these, too, often sustain loss. Does he start all over and plant another spring crop, or does he take a chance there'll be enough recovery in his field to make a profit? One means of minimizing the risks in this decision is to lower the risk involved in winter wheat production. To do so requires a more complete understanding of the weather and the responses of plants to it.

Do Plants Winterize?

In recent years certain insects have been shown to produce a substance in the cells of their body in the fall that functions much the same as antifreeze in radiators. The effect is that the chance is reduced for damaging ice formation in their cells.

There's no evidence to show that plants winterize in the exact way as insects. The exposure of plants to cool fall conditions does cause changes, however, that prepare them for winter. These changes (or cold acclimation) can be triggered under laboratory conditions. It has been found that temperatures near freezing for a period of at least a month are required for cereals to winterize.

Corn and other summer annuals have little or no ability to acclimate to cold and therefore cannot withstand temperatures much below freezing. In contrast, most plants that over-winter have some potential for acclimation. Within a given crop a range in winter hardiness exists, as a result of plant selection programs.

The degree of winter hardiness of a plant seems, in our opinion, to be closely allied with the intensity of reactions that develop during the acclimation period. It also appears that hardiness cannot be attributed to a single reaction. A hardy plant is one that contains the best combination of factors to resist the climatic hazards of a geographic region.

The fall season is important, yet we know how variable fall weather can be. Can plants winter kill as a result of an inadequate preparation period? What happens to plants in those years when weather changes directly from summer temperatures to winter readings? What about those times when we experience Indian summers?

It appears unlikely that such unusual conditions in the fall have any serious consequences on plants for at least two reasons:

(1) We need to keep in mind that much of our experience with

The discussion on this and following pages of winter hardiness in small grain is a progress report on research being conducted cooperatively by two departments of the Agricultural Experiment Station. The authors are D. G. Kenefick, associate professor, Plant Science and Station Biochemistry Departments, and E. I. Whitehead, professor, Station Biochemistry Department.

PROSPECTS FOR PROGRESS

The winter hardiness problem of plants in South Dakota may be caused by too much "heat" at the wrong time of the year, according to two Agricultural Experiment Station scientists in the accompanying research progress reports.

If the temperature-timing combination leads to the start of growth, plants become vulnerable to freeze injury. The problem in South Dakota is particularly serious in early spring when the chances of subsequent sub-freezing temperatures remain high.

In discussing winter hardiness research, the authors say evidence suggests that existing hardy varieties often have the capacity for stalling growth during short warm periods. There appears to be considerable genetic variability in cereals which would permit a further selection of plants that are slow to respond to unseasonable warm spells. This solution is not without its problems, however, for when spring does come (that is, no further danger of freezes) it is essential that plants grow vigorously to produce a competitive grain yield.

The authors suggest that more hardy varieties of the future may need to be "slow starters" in the spring to cope with hazards of weather and that such plants will need to be treated with a growth stimulant, perhaps at the time of spring herbicide application, when the risk of freeze is low. Currently, the scientists add, it appears certain that we will need a better understanding of how different crop varieties respond to unusual climatic conditions.

The most recent and advanced techniques are being used in South Dakota State University research to examine some of these complex factors of plant growth and winter hardiness. Part of the new Plant Science building now under construction on the campus will be used to continue and expand this research which has important implications for South Dakota wheat production.

weather is based upon *air temperature*. Critical growth regulatory centers of cereals are located below the soil surface. The rate of temperature drop is dependent upon not only air movement and temperature, but also heat stored in the soil from the previous summer. Air temperatures are moderated by the soil and there is a slow gradual drop in soil temperature in response to progressively cooler air and the shortened day-light period.

(2) As temperatures decline the plants increase their ability to withstand freezing temperatures.

It is well recognized that cold acclimation by plants is slow, requiring not only low temperatures but also a time period of at least a month. Reversal of acclimation (or deacclimation) requires moderately warm temperatures but a period of only a few days. At first glance, periodic warm fronts might be considered responsible for deacclimation. It is doubtful, however, that these fronts have much influence on plants in the fall. First, the chance of occurrence is reduced as the season advances and, second, if a warm front moves through as late as 2 months after the fall equinox its *effect* upon the soil is reduced considerably because of the shortened day-light period.

Spring in South Dakota and Winter Hardiness

Deacclimation in early spring is viewed as a distinct possibility in certain years. Both the grower and researcher recognize that if temperature rises and plants start growing, a subsequent freeze is often fatal. The problem is one of identifying when deacclimation conditions occur in plants. It is likely that these changes precede any growth response by plants.

Table 1. Freeze survival of winter barley plants after cold-treatments (4 weeks at 32° F.)

	% Survival after a 12-hour freeze at 22° F.	
	Hardy	Nonhardy
Test 1	71	14
	76	30
	69	12
Test 2	47	10
	64	14
	51	6
Test 3 (No cold treatment)	0	0

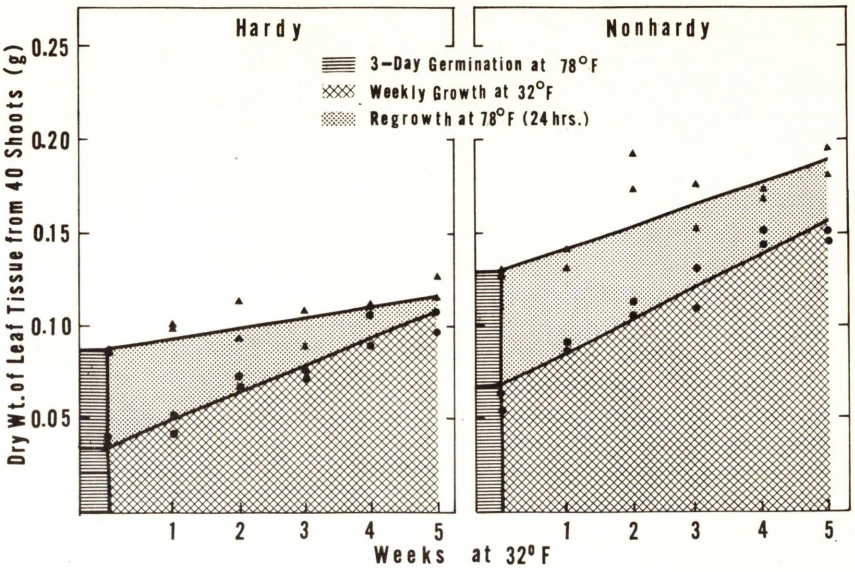


Figure 1. A comparison of leaf growth rates (dry weight) of a hardy and nonhardy winter barley during and after 32° F. acclimation.

In contrast to fall conditions, warm fronts in the spring are considered a more serious hazard. Two months after the spring equinox the day-length has increased by an amount equal to its decrease in the fall. The longer daylight period augments the effect of warm fronts on the top few inches of soil. Early spring can have a similar effect in which plants show such growth responses as greening of leaves, yet the soil may still be frozen below the root zone. The risk to plants is that if air temperatures drop, the soil no longer moderates the effect but actually assists the freezing process. Chances are high in South Dakota that we can encounter early spring thaws of sufficient duration for deacclimation and still have high probability for a severe freeze to follow such periods.

Snow cover is helpful in preventing drastic rises in soil temperature because it is a good insulator. As contrasted to dark soil it is also very effective in reflecting sunlight. The benefit of snowbanks is often shown in stand counts on the leeward side of shelter belts. In South Dakota we often do not have snow on our fields, so the spring "heat" problem is intensified. Mulching is a recommended practice which is merely an attempt to buffer temperature extremes. Mulching is often viewed as protection for the crop against cold in the dead of winter. It should also be considered as effective in delaying soil temperature rise in the spring.

What About Winter Temperatures?

South Dakota winters are long and cold. Do these factors have any influence on crop survival? Unfortunately, our recollections and the weather records only reflect air temperatures. There is certainly a relationship with soil temperatures but again the soil is influenced by factors such as soil moisture, crop and snow cover. The variability of this relationship from year to year complicates our views as to what specific climatic factors result in winter kill. More complete records would be helpful in determining how extensive actual winter season damage can be.

The Nature of Plants

Apart from the practical observations of growers, the shortness of the deacclimation period, and the features of South Dakota weather, there is still another reason why early spring thaws are considered a persistent crop hazard. The nature of many hardy crop varieties is a lack of fall growth when compared with less hardy types. This difference has been found to be due to small growth additions made by nonhardy plants during each warm day-light period.

Proof of this possibility was obtained by comparing dry-weight increases (growth) of hardy and nonhardy winter barley plants under laboratory conditions (Figure 1). What happens if plants are sud-

denly transferred to a warm environment (78° F.) after an extended cold period? The objective was to simulate one warm day after each cold period. A minimum 24-hour warm period was necessary so that growth could be detected by the weighing method used.

A comparison of the slope of the lines in Figure 1 can be used to evaluate growth. The lower line in each chart is a measure of growth at weekly intervals at 32° F. Essentially no difference in the growth rate between varieties was detected at this temperature for a period up to 5 weeks.

The most significant finding was that as the cold period became longer the amount of growth of the hardy variety during the warm period was reduced. The slope of the upper line through this data was not as steep as that for the nonhardy variety. The distance between the upper and lower lines (indicating growth), became less for the hardy variety as the cold period increased.

A closer analogy of this experimental approach to the high day and low night temperatures of the fall needed to be made. How much can the 24-hour warm period be shortened and still cause a growth response by the nonhardy variety? After all, the above explanation for growth difference of nonhardy plants would need to be based on a warm exposure period of less than 12 hours, more consistent with the normal length of the fall day-light period.

Growth measurements were made more precise by using radioactive isotopes. The initial one used (radioactive phosphorous) permitted measurement of nucleic acid synthesis. These are compounds essential for cell division and growth. A sudden increase of isotope content in nucleic acids suggested the start of growth.

A summary of these experiments is shown in the diagram of Figure 2. The results confirmed that considerable activity existed in the nonhardy variety in the period after 8 to 12 hours of deacclimation.

It is concluded that nonhardy plants do not respond to cold acclimation as extensively as do the hardy plants. Their metabolism is not "confused" by low temperatures and therefore they can resume growth almost immediately when temperatures rise. This suggests that hardy plants contain genes which bring about acclimation. The result of such reactions is not only to prepare cells more adequately for winter, but also to delay growth for a longer time during warm spells in the spring.

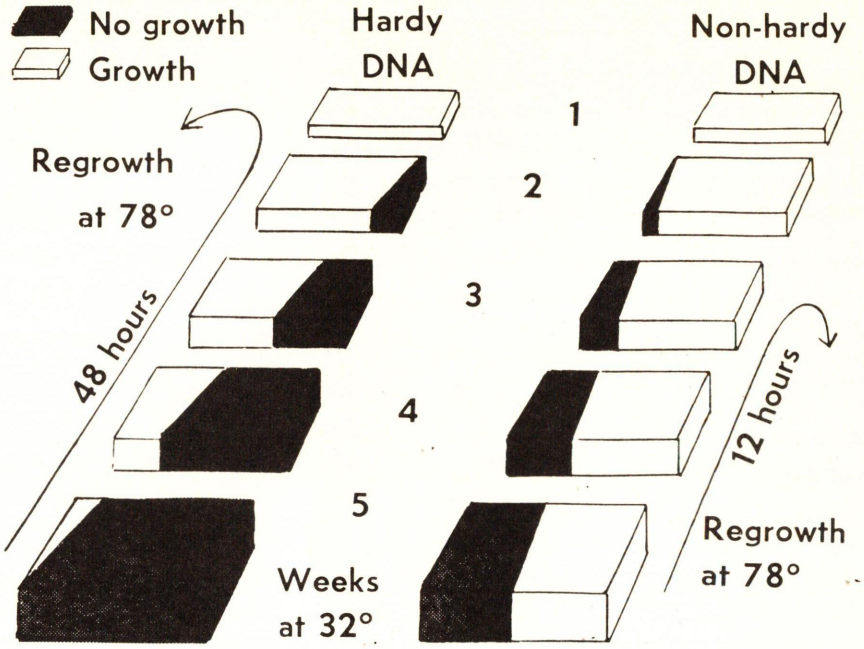


Figure 2. Diagramatic representation of the effect of 32° F. on growth inhibition of a hardy and nonhardy winter barley (shown as DNA) and the time responses for regrowth at 78° F., as determined by radioactive phosphorus incorporation into nucleic acids (RNA).

The selection of barley as the experimental crop has furthered our progress in this research. Geneticall y it is much simpler than other choices, such as wheat and therefore is preferred for experimental purposes. There is good evidence that much of the information obtained about barley will be interchangeable with other crop plants. A more detailed explanation of the changes in the hardy variety during acclimation is discussed elsewhere in these articles on winterhardiness. Much of this research has resulted from techniques developed at SDSU.

Consequences to Plant Selection

We have suggested that a hardy plant might be described as having two inter-related responses to low non-freezing temperatures: (1) its genetic make-up must be such that cool fall nights prevent growth during the warm day period, (2) it must contain genes that are activated by the cold to initiate the acclimated state. Both cold responses are essential for maximal hardiness but they may not be separate reactions. At present it is convenient to describe the responses in this way because the second response is viewed not only as necessary for the development of maximal freeze protection but also it assists in stalling growth during unseasonable warm spells. Something happens beyond just stopping growth.

The above analysis is a "guess" based upon our data and the traits of hardy and nonhardy plants. This analysis is helpful in attempting to sort out complex factors contributing to winter hardiness of plants. Its reliability is based largely upon traits which have been inadvertently incorporated into hardy varieties in breeding programs. Can we take advantage of the "fall growth trait" to increase winter hardiness by plant breeding?

What Do You Want— Good Yield or Good Stands?

This version of the current cigarette advertisement suggests that you cannot have both good yields and good stands. It is questionable that this is true, but it suggests a possible paradox. Nebraska growers continue to look for more hardy winter

(Concluded bottom next page)

In Plant Cells . . .

Possible Sites of Growth Regulation by Temperature

THE PREVIOUS report beginning on page 36 draws attention to the fact that plant growth and winter hardiness appear to be in opposition to each other. It could be said that winter hardiness is not growth. Might we learn something about winter hardiness if we better understood growth? A "yes" answer to this question has been considered for two basic reasons:

1. Today we know much about the sequence of chemical steps which lead to growth. There is good reason to suspect that the development of winter hardiness follows a similar pathway, but it appears that cold acclimation of plants alters the product of the pathway in hardy varieties.

2. A description of growth at this chemical level is in many ways identical with that of describing how information from genes is transmitted to direct the destiny of a plant. Thus, winter hardiness as an inherited trait can be examined, along with growth, from the standpoint of how cold acclimation may influence these chemical reactions.

In many respects the chemistry of *all* living systems has a certain unity, yet exceptions do occur. What follows is an attempt to: (1) briefly outline these common reactions, and (2) report some things we have learned at South Dakota State University about the exceptions due to the influence of temperature on a hardy and nonhardy winter barley.

Basic Reactions

Tremendous strides have been made in biology toward understanding the ways *(mechanisms)* by which the hereditary information stored in the genes of cells is reproduced *(transcription)* and converted into forms which direct *(translation)* the synthesis of the chemical substances necessary for life. Specialized forms of compounds, called *nucleic acids,* are involved in the processes of transcription and translation. The genes are largely made up of deoxyribonucleic acids (or DNA) and are found in the nucleus of the cell. Transcription of the various genetic traits found in the genes into chemical compounds involves the initiation and build-up *(synthesis)* of messenger ribonucleic acids (mRNA) in the nucleus of the cell. The mRNA's are assembled to match specific patterns (template) provided by the DNA molecules. These transcribed genetic messages

(Continued on page 40)

SEARCH FOR WINTER HARDINESS . . . from page 38

wheats. Why don't they use the ones developed in South Dakota where more severe winters exist? The problem might be that our wheats have a desirable level of winter hardiness for Nebraska conditions, but are slow to start growing in the spring. That is, the South Dakota wheats do not deacclimate fast enough for Nebraska conditions. The result is that good stands are retained but, on the average, yield advantage is lost. A less hardy variety may suffer loss in stand but it can detect spring faster. This variety might be able to compensate for stand reduction by its ability to tiller profusely and grow with vigor.

A similar analogy can be applied for South Dakota conditions. It is possible that many good hardy lines have been eliminated from our breeding programs because they do not yield as well as commercial varieties. Most of the time we can get by with recommended varieties in the winter wheat areas even when some stand reduction occurs.

Solution to Apparent Paradox

This is only a limited analyses of the entire winter hardiness problem. It is directed, however, toward some of the critical problems of winter cereals in this state. Much of the research of this program is guided toward learning about growth regulation systems in cereals.

One approach proposed by some investigators is the use of growth retardants to improve winter hardiness. This does not appear to be a practical solution for cereals. We propose that with an adequate understanding of growth regulation, growers will be able to "start" their crop in the spring when they and the weatherman decide that the freeze-risk is low.

Artificial stimulation of growth (possibly by spraying plant growth stimulators) could be necessary in the future, because growers may be planting new winter wheat varieties in which the plant breeder has developed a high degree of winter hardiness. This approach appears likely because long-range weather prediction will improve and will provide more accurate information for the grower who then can make profitable adjustments to weather changes.□

(mRNA's) move out of the nucleus into the cytoplasm of the cell, where they assemble particles of ribosomal ribonucleic acids (or rRNA) in an order specified by the genetic message. These assemblies of rRNA particles are called polyribosomes. The production of genetically specified proteins (translation) takes place on the polyribosomes. The basic steps of polyribosome formation and protein synthesis are shown in Figure 1. This process also requires the presence of transfer ribonucleic acids (or tRNA) which carry specified amino acids to the site of protein synthesis (the polyribosomes).

Method of Determining mRNA Synthesis

Proteins are necessary for the subsequent production of all compounds essential for life and growth. Ample evidence exists to indicate that low temperature can inhibit or restrain certain intricate steps leading to protein production. The first logical step to examine was the ability of cold acclimation to influence production of mRNA (transcription) in a hardy and nonhardy barley. The mRNA's are measured indirectly by determining the kind of polyribosomes assembled, both as to size (the number of rRNA's in the polyribosomes) and the amount of polyribosomes of each size. The predicted alternative possibilities in cells are shown diagrammatically in Figure 1 (with mRNA) and Figure 4 (without mRNA).

The ultracentrifuge (shown in Figure 2) is used for the purification and separation of ribosomal particles. This instrument generates centrifugal forces of more than 100,000 times the force of gravity. Its principal of operation is similar to that of a cream separator—the heavier polyribosome particles being forced farther into a sugar solution, which increases in density (sugar content) with tube depth. Polyribosomes with the same number of assembled ribosomes tend to seek the same level in the centrifuge tube. After a 3-hour spin at a force of more than 100,000 times gravity, they exist as separate bands in the sugar gradient (Figure 6). Single ribosomes are grouped slightly below the 10% sugar concentration (see Figure 5) at the top of the centrifuge tube, while polyribosomes, consisting of six ribosomes, for example, form a band in the middle of the tube at about the 25% sugar content level (see Figure 6). The concentration of polyribosomes in each band is detected and measured by the instrument shown in Figure 3. Measurement is based on the amount of light absorbed by each polyribosome band as it passes between an ultraviolet light source and a photocell.

Does Acclimation Affect Polyribosomes?

The band of single ribosomes shown in Figure 5 would be expected in the sugar gradient if no mRNA's were produced during a 32° F. cold treatment period. However, several distinct bands of polyribosomes were actually found in the cold-treated barley plants (as shown in Figure 6). This result is identical with that found for similar plant tissue grown at 78°F. The observed lack of growth by the hardy barley plants after cold treatment cannot be explained simply on the basis of a shortage of polyribosomes. Since polyribosomes were present, the next step was to determine if proteins were being synthesized (translation), as shown in Figure 1.

Protein Synthesis Without Growth

Protein synthesis is essential to growth. The above evidence suggested the possibility that protein synthesis was absent in the hardy plants after cold treatment because no growth was observed. The method used to measure protein synthesis is based on a radioactive tracer, selenium-75. A large part of the

Figure 1. A diagram of a portion of a plant cell in *active growth* showing the process by which information from the nucleus (mRNA) specifies the synthesis and release of proteins in the cytoplasm.

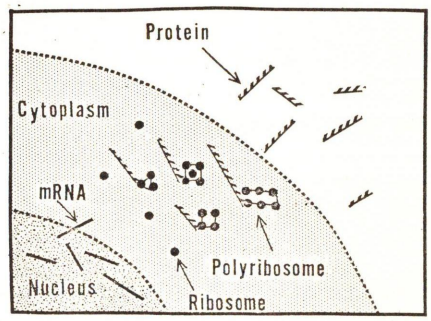
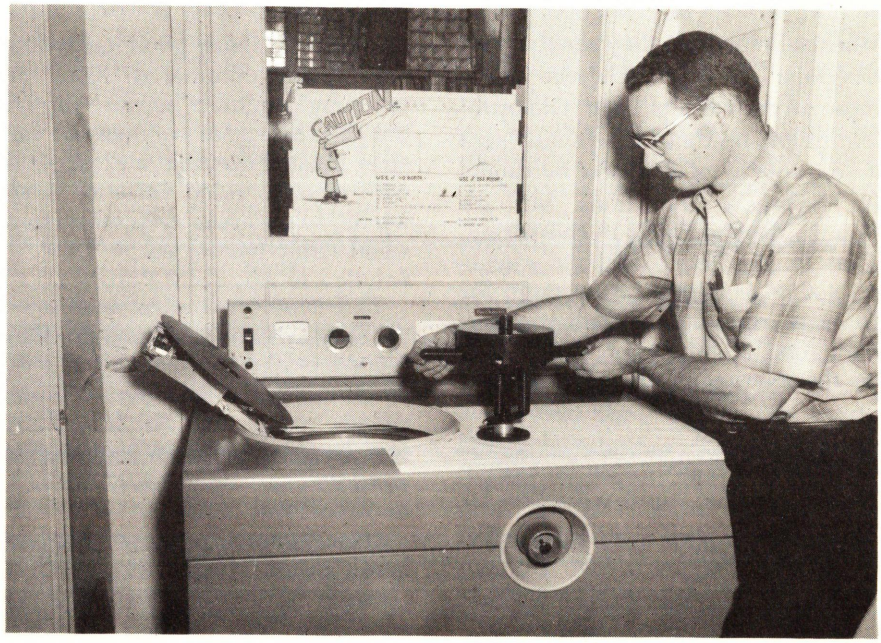


Figure 2. The different sizes of polyribosomes are separated by the ultracentrifuge shown here. This process is made possible by placing a cell extract in the top of a tube containing a 10% to 35% linear sugar gradient. The sample is spun in the rotor which is ready to be placed in the chamber by Clay Johnson, graduate research assistant, who demonstrates horizontal position of swinging tube-containers.▼



selenium (as selenite) added to barley plants has been found to be incorporated into the compound, selenomethionine. (This compound is similar to the amino acid, methionine, except that the sulfur atom of normal methionine has been replaced by selenium). Proteins from the selenium-75 treated barley plants were obtained by centrifugation of the homogenized plant tissue, followed by purification (gel filtration) and enzyme digestion into the component amino acids. The radioactivity present in the selenomethionine fraction is determined with a gamma-ray counter. The amount of selenomethionine found in the proteins of the barley shoots is used not only to measure their capacity to make proteins, but also to determine the rate of protein synthesis in these plants.

Several experiments have shown that the rate of protein synthesis at 78°F. is only slightly altered in the hardy barley variety receiving an earlier cold treatment at 32°F. (compared to similar plants grown at 78°F. without cold treatment).

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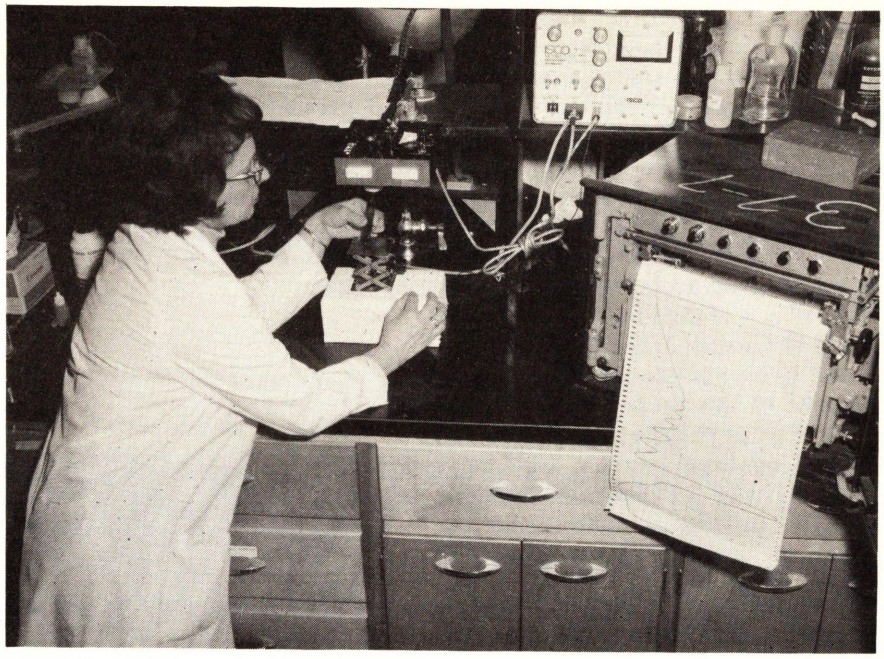


Figure 3. Distribution of polyribosome particles in the sugar gradient after centrifugation is measured and recorded by this instrument as demonstrated by Mrs. Teresa DeBoise, research assistant.

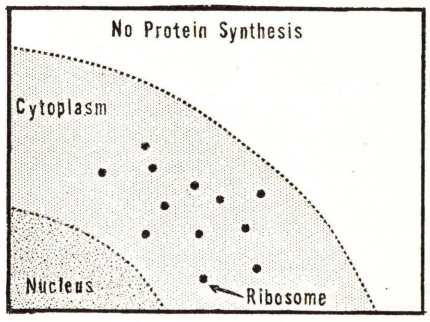
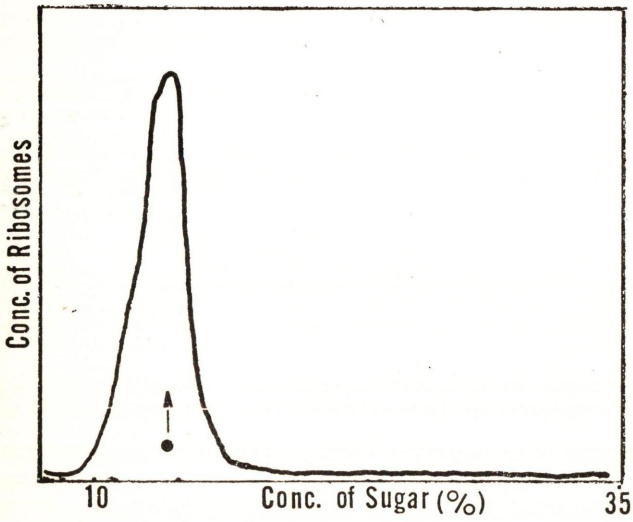
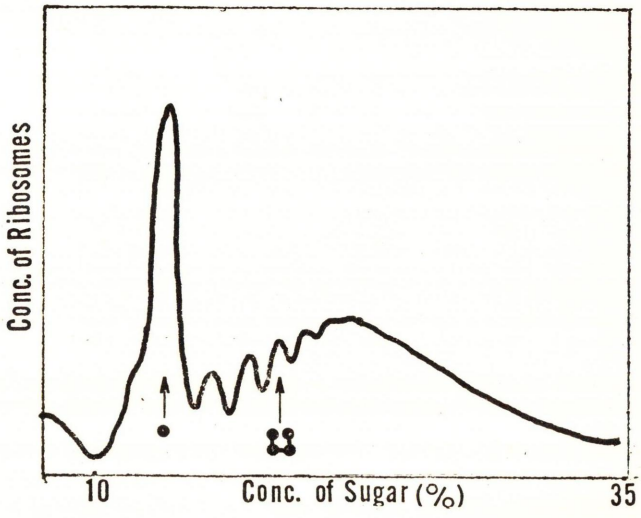


Figure 4. This diagram shows an *expected* result *if* an absence of mRNA caused the lack of growth after cold acclimation of the hardy variety.

Figure 5. *If* Figure 4 reflects the actual condition of cells from an acclimated hardy variety, then results of sugar gradient analysis would be *one band* of single ribosomes as shown below. (Visualize a tube lying horizontally, the tube position during centrifugation, with the cell sample layered to the left of the 10% mark and the bottom of the tube at the 35% mark.) ▼

Figure 6. This graph represents an *actual* result of polyribosome distribution from cell extracts of the hardy variety *before* and *after* cold acclimation. Cold treatment *does not stop* mRNA production (transcription) as indicated by several bands of polyribosomes in the gradient (arrows indicate relative position of the one- and four-ribosomal clusters). ▼

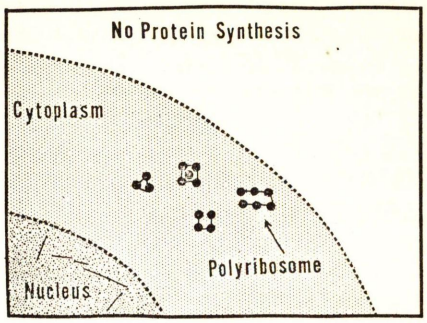




The lack of growth in these cold-treated plants, therefore, implies that this protein synthesis may be a remanent of the cold-acclimated state in which functionally altered proteins were made. On the other hand, a nonhardy barley variety shows a several-fold increase in selenomethionine-protein production after cold acclimation, compared to plants of the same variety held at 78°F. Growth in this case was not found to be inhibited, and a certain amount of this protein synthesis is attributed to re-growth in the cold-treated nonhardy variety. Comparing the hardy and nonhardy barley varieties in their responses to cold treatment, it seems that cold is capable of triggering a modification of the transcribed genetic message (mRNA) in the nucleus of the hardy plant cell.

A summary of results obtained from a study of these basic biological systems has shown that the *nonhardy* variety has a *high level* of protein synthesis after cold acclimation when compared to the hardy one. These results are therefore consistent with the *active growth* of the nonhardy one after cold treatment. As yet the chemical conditions which prevent a similar surge in synthesis and growth of the hardy one after acclimation have not been revealed. The fact that polyribosomes exist and that some proteins are being made show that acclimation has not caused drastic alterations in the cell. These results and other more recent findings support the conclusion that growth is regulated by temperature at this subcellular level.□

Figure 7. This diagram shows the next tentative conclusion: that mRNA *is produced* (polyribosomes are present) during cold acclimation in the hardy variety, but that low temperature *stops* protein synthesis (translation). This would be in contrast to the complete system shown in Figure 1.



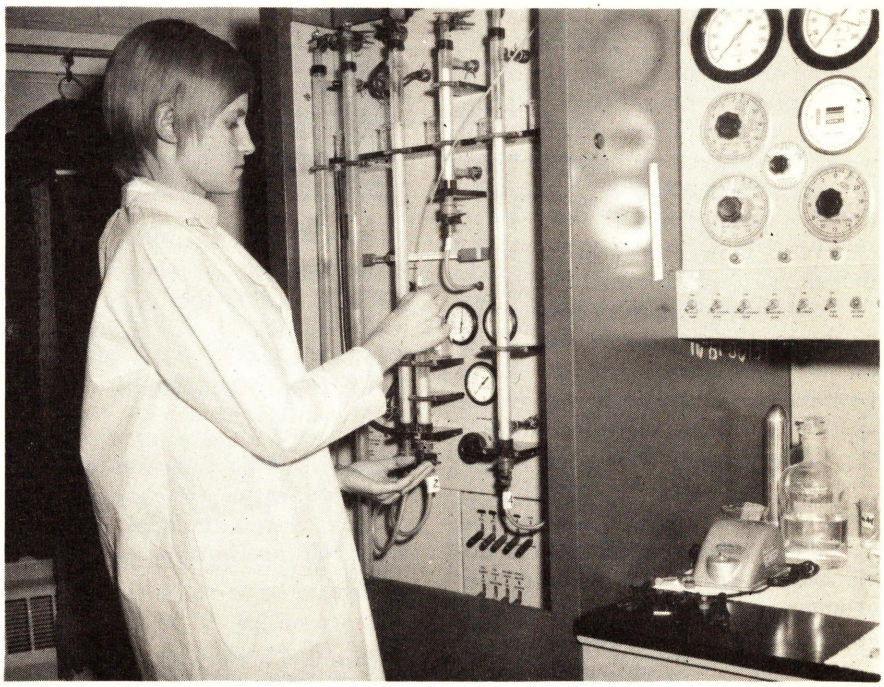


Figure 8. The amino acid analyzer (above) is used to separate selenomethionine from other amino acids of the protein digest. This instrument, together with the gamma-ray counter, has shown that cold treatment *does not* stop protein synthesis in the hardy variety (contrary to the proposed scheme in Figure 7.) Mrs. Elaine Nelson, technical assistant, makes an adjustment of the instrument.

Two Calves Where Only One Before?

SOUTH DAKOTA State University has a major part in a new regional research effort aimed at improving reproduction in beef cattle.

The SDSU contribution is a 3-year Agricultural Experiment Station project with the objective of increasing frequency of twinning in beef cattle to boost reproductive capacity of cows.

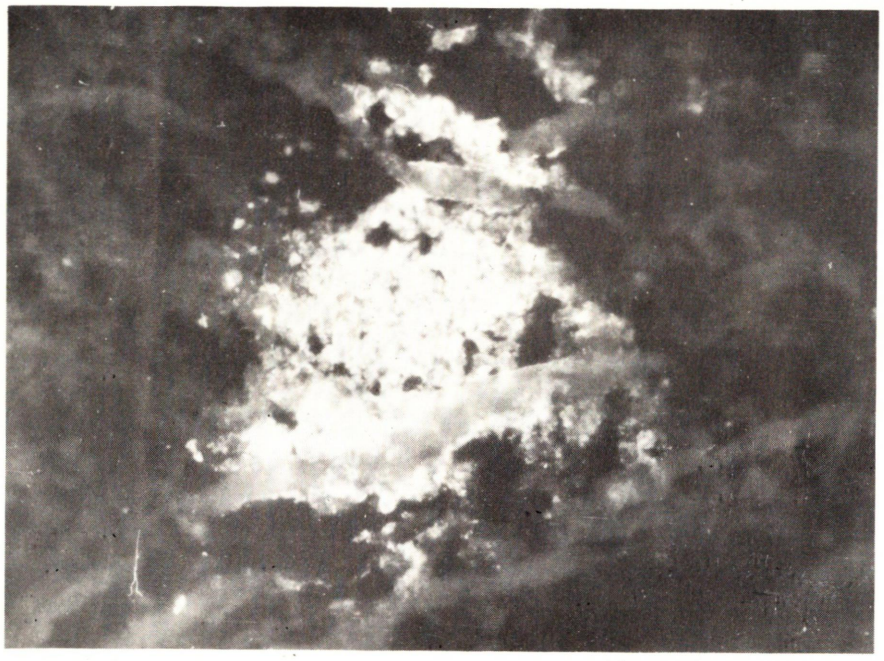
Scientists from 14 western states and the U. S. Department of Agriculture last year began what is described as one of the most diversified attacks ever attempted to find ways of increasing percentage of cows weaning healthy calves. Travis Rich, assistant professor in the SDSU Animal Science Department, will be project leader for the South Dakota research at Brookings.

Dr. Rich, whose specialty is animal physiology and reproduction, points out that the coordinated approach by veterinarians and animal scientists is expected to yield significant results in a shorter time than would be obtained by the same scientists working independently. Results that can be used by cattlemen are anticipated within a 5-year period on some of the problems, he adds. The regional committee of scientists will meet annually for progress review and making adjustments in projects if necessary to attain maximum success.

"As we learn more about induced twinning, we'll be getting into some new management problems involving the beef cow," explains the SDSU animal scientist. "Plus the fact there will be an extra calf, multiple pregnancies reduce birth weight, gestation length and certain breeding problems have a higher frequency. With this in mind, the twin-bearing cow could be a different kind of animal in some aspects than what we are accustomed to managing."

Other states will conduct research dealing with control of scours, elimination of abortion, studies of sexual maturation in heifers through use of nutrition and hormones, methods for reducing the length of the period from calving to next conception.□

Diagnostic Breakthrough



A new method which reduces the time from a week to 2 hours for diagnosis of infectious bovine rhinotracheitis (red nose) abortion in cattle has been developed by the South Dakota Animal Disease Research and Diagnostic Laboratory on the SDSU campus. Fluorescence in tissue as seen through an ultraviolet iluminated microscope (above) is a key factor in the diagnostic breakthrough. See page 24 for additional details and discussion of "Abortion in Cattle."

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